THE ENGINEERING MAGAZINE

THE WORLD IS ITS FIELD

VOL. XXIV. NOVEMBER, 1902. NO. 2.

THE PRESENT INDUSTRIAL IMPORTANCE OF TECHNICAL EDUCATION.

By Sir Philip Magnus.

The importance of the problems of technical education and the present great activity of interest in the topic were recognised in our leading review last month. The following discussion by Sir Philip Magnus shows the trend of the thought and effort of the leaders of the movement in Britain, and may very profitably be read in connection with the review of three important papers by other great authorities on page 267 of this number. It is especially noteworthy that while Britain looks to Germany as the model, Germany is arraigning her own system as insufficient. It is doubtful, furthermore, if the United States can show anything which in scope, in purpose, and in magnitude compares with the great technical schools at Manchester, Birmingham, or Sheffield.

Sir Philip has been for more than twenty years in the forefront of progress in British technical education, as director of the City and Guilds of London Institute, member of the Royal Commission on Technical Education, of the Senate of the London University, and of the Technical Education Board of the London County Council.—THE EDITORS.

DURING the last few years so much has been written on the subject of technical education, and so much has been done by Parliament, by county councils and by the livery companies of London, to bring its advantages within reach of all classes of the community, that it would seem there is no further need to insist upon its importance, and that nothing new can be said on so trite a subject. This may be so. Nevertheless it is a fact that some of our industries have suffered, and are still suffering, through lack of interest in this important question, and owing to the insufficient efforts that have been so far made to place Britain educationally on a level with Germany and the United States.

The delay in meeting requirements which have been so frequently pointed out, is perhaps partly the result of the exaggerated statements so frequently introduced into the discussion of this subject. Practical men have refused to believe that our industrial shortcomings are due entirely to the lack of educational facilities. They recognise that in this question of trade competition other considerations than those of education are factors of material significance. Among the social and economic causes of a country's industrial prosperity or failure must be included such considerations as commercial tariffs, hours of labour, trades-union regulations, means of transport, the laws regulating patents, as well as the essential character of the people—a matter which cannot be hastily altered by the foundation of any number of technical institutes. That technical education is the panacea for all the evils of which manufacturers and merchants and agriculturists from time to time complain, cannot for one moment be admitted. At a time, too, when the Board of Trade statistics shew that the commercial condition of the country is fairly prosperous; when enormous sums of money can be taken out of capital for unproductive expenditure, without interfering with or dislocating trade; when British manufacturers are unable to meet the heavy orders which they are receiving,—the statement that their competitors in Germany, Switzerland, and the United States are gaining ground on them, and that Britain is gradually losing one branch of industry after another, for lack of adequate education, would seem at least to need some qualification.

Then, too, it cannot be said there is that agreement which is desirable among the educational physicians, who so readily prescribe for us. Not long ago we were told that our artisans were lamentably deficient in technical knowledge and skill, and the public was asked to make large contributions towards the establishment and maintenance of polytechnic institutions, with the view of stemming the flow of foreign imports into this country. Others warned us that the reason of our inability to hold our own in trade and commerce was the absence of all organisation in our secondary schools—that the teaching was defective and the scholars in attendance were too few—while other equally eloquent advisors insisted that our recovery lay in the provision of further facilities for the higher technical instruction, in the establishment of new universities, in the endowment of research, and above all in the abolition of examinations.

With the view of demonstrating our inferiority to Continental countries, in one or more of these respects, enquiries have been instituted

into foreign educational systems, blue books and special reports have been published by the Government, and private commissions have been sent from several of our large manufacturing centres, with the result that probably no people are better informed as to their neighbours' educational facilities and methods than we are. Even now, further enquiries are being made; and it is understood that an important body of experts will start in the late autumn to make new investigations into the organisation of trade and education in the United States and in other countries. It is very doubtful, however, whether we can expect to gain much by fresh enquiries, and it might be well if the people of Great Britain would recognise that the time has now come for applying the information we have already acquired to the remedying of such defects in our educational system as may have been proved to exist. Whilst such a survey of our deficiencies is very desirable, it would be lamentable if we were to attempt to remodel our methods altogether on foreign lines. A nation's educational organisation is a part of its history and character, and must be adapted to its special industrial requirements. The information we have obtained as to the relations which other countries have established between trade and training is eminently useful in shewing us:—(a) The particular industries, if any, which we have wholly or partially lost through our educational shortcomings, and the extent to which other countries have benefitted by any superiority in their methods or organisation; (b) The extent to which trade and commerce may be helped by technical or other schools; and (c) The relative degree of appreciation among different countries of the value of education in the promotion of industry. Such information will be found in some of the documents to which I have referred, and more fully in the Consular Reports, which do not appear to be as carefully studied as they should be by those whose interests are most affected by the valuable facts and statistics they frequently contain.

Of such reports one of the most informing was that issued in July, 1901, on "Chemical Instruction and Chemical Industries in Germany" by Dr. Frederick Rose, His Majesty's consul at Stuttgart. Dr. Rose has had the advantage of studying chemistry in German laboratories, and his residence at Stuttgart, the seat of one of the best technical high schools, had given him the opportunity of carefully investigating the extent to which German trade had profitted from the higher technical training which such schools provide. Dr. Rose tells us that the principal object of his report was "to shew the direct influence of chemical instruction upon the growth of chemical industries," and the

facts and figures he adduces prove unmistakably that the great development of the chemical industry in Germany is due very largely to the foresight of the different States in providing facilities for the thorough training of chemists. There can be no doubt that Germany's success has been very largely due to the fact that manufacturers and managers in every department of industry have been themselves sufficiently well educated to recognise the advantage of scientific, as distinguished from rule-of-thumb, methods; and this appreciation of the value of science on the part of those who have been and are in a position to avail themselves of its methods and results, has been one of the most potent factors in the development, during the last fifty years, of trade and commerce in Germany. Mr. George Beilby, a chemical manufacturer of Glasgow, states in the appendix (to a report to which fuller reference will be made later on):

> "I attribute the leading position of Germany in certain chemical industries more to the appreciation by her commercial leaders of scientific methods than to the mere possession of a multitude of higher trained graduates in science." * Let us now consider some of the facts Dr. Rose has been able to collect. He tells us: "The growth of the German chemical industries has advanced hand in hand with the progress and discoveries made in chemical science and the increased facilities for chemical instruction. The annals of industrial progress shew few examples of such intimate relationship between pure and applied science. The chemical industries in Germany, in common with other industries, were slower in their development during the first half of the nineteenth century compared with France, the United Kingdom, and the United States, but recovered lost ground with great rapidity during the latter part of the century."

It is very difficult to over-estimate the benefits conferred upon agriculture by the discoveries of Liebig. It was he who in 1840 shewed that if soils are not to become impoverished, those salts of which they are deprived by agriculture must be restored to them, and this discovery led to the working of the salt mines of Stassfurt, and of the Anhalt salt strata. "The total value of the production from Prussia and Anhalt between 1860 and 1890 amounted to £11,500,000." Prior to 1860, Russia had exported to Germany large supplies of potash, but since then Germany has imported less and less, and in 1887 Russia began to import German potash. Experiments, begun in German laboratories in 1855, shewed that potassium saltpetre previously imported from the East Indies could be more cheaply manufactured, and as a result of these experiments, the importation of potassium saltpetre into Germany has entirely ceased, and in the year 1899, 13,-

* Report of the special committee of the Technical Education Board of the L. C. C. on "The Application of Science to Industry." p. 27.

361 tons were exported to other countries. The increase in the production of beet sugar from 8,822 tons during the years 1836-40, to 1,664,677 tons in 1899, is a further remarkable example of the progress of German trade due to commercial enterprise.

The report from which these facts are quoted contains many other instances of the developement of chemical industries in Germany. The most remarkable of these, and the one most frequently adduced, is the rapid growth of the manufacture of artificial colouring matters. Some of the principal discoveries which led to this important industry were made in England, and it is from England that the raw material is largely exported. Moreover, from 1858 to 1872, the bulk of the business was carried on in London, whereas since then, owing almost entirely to the succession of discoveries in German laboratories, and to the rapid application of those discoveries by well trained intelligent manufacturers, the industry has practically left us. "Of the world's annual production of alizarine in 1890, amounting to about 25,000 tons. Germany contributed about 22,000 tons." In 1874 the value of the dye industry to Germany was £1,200,000, and in 1898 it had increased to £6,000,000, and the excess of exports over imports amounted in value to £4,891,100. Not content with this increase of trade, the principal dye works in Germany are preparing to erect branch establishments in America, France, and Russia.

In 1882 I was shewn by Professor Beyer in his university laboratory in Munich a comparatively simple means for the artificial production of indigo. At that time, the discovery was not ripe for manufacturing purposes. The indigo was produced in small quantities in a test tube. Since then, the import into Germany of natural indigo, which in 1886 amounted to 1,036 tons, has altogether ceased, and in the year 1899 Germany exported 256 tons of the same material artificially prepared. It is claimed, too, that the new indigo is in many respects superior to the natural product, in which the percentage of colouring material, instead of being fixed, is a variable quantity. As affecting our own trade it may be mentioned that the value of the export of indigo from India has decreased from 51,92,672 Rs in 1899 to 27,85,627 Rs in 1900.

I might quote largely from other documents to show that Great Britain, notwithstanding her present large volume of trade and her continued commercial success, has been losing ground as compared with the United States and other countries in certain branches of industry. The commercial prosperity of a country cannot be correctly estimated by the actual value of its exports and imports; it is the com-

parative rate of developement which marks its progress. For if it can be shewn that other nations are gradually gaining on us, and that we are living, so to speak, on our capital, both as regards stored-up resources and *prestige,* the time may come when we may find ourselves dangerously distanced by other countries in the competition for trade, and it may then be too late to organise those means of self-defence and attack which have been successfully employed by our foreign competitors.

In the report of the special committee of the London County Council, to which I have already referred, it is, I think, conclusively shewn that of late years we have lost other branches of trade than those above named, and that this loss is largely due to the superior educational equipment of our neighbours. An industry which we are rapidly losing is the production of fine glass for scientific and optical purposes.

> "A generation ago, the bulk of this manufacture was in English hands. After long continued experiments in the laboratory, German chemists have succeeded in introducing such modifications in the manufacture of optical glass that the optician has been enabled to place on the market lenses approaching more nearly to mathematical perfection than any previously manufactured in this country. It is also worthy of notice that the experiments carried out in connection with optical glass have created in Germany several subsidiary industries."

This developement of subsidiary industries is a fact of considerable importance. There are bye-products of experiment, as of manufacture, and these bye-products are often found to be commercially more valuable than the results for which the original experiments were undertaken. The report goes on to say that among those subsidiary industries, now almost wholly in the hands of the Germans, are the manufacture of thermometers for accurate physical measurements; the manufacture of X-ray tubes, the manufacture of lamp chimneys which do not burst, and boiling flasks which do not crack. The help these industries have obtained from scientific experiments carried on by subsidies granted by the Prussian Bureau of Education, is fully acknowledged in the introduction to the price list of the Jena Glass Works.

Recently, in London, classes for the study of trade optics have been established, under the auspices of the Spectacle-Makers' Company, at the Northampton Institute, Clerkenwell These classes, although serving a very useful purpose, fail to give that complete scientific training which the practical optician requires. What is wanted is a well-equipped department in connection with one of our university technical schools, in which research work in the manufacture of the

material itself, and in the scientific principles underlying the production of optical instruments, may be conducted by specially appointed professors assisted by their students.

In certain branches of the pottery trade we are also losing ground, through the superior education of our Continental rivals. No one can have visited a pottery in Staffordshire without comparing it to its disadvantage with some of the most up-to-date firms in France and Germany. The absence of any attempt at applying scientific method and scientific processes is characteristic of most of our English potteries; and one is struck with the fact that, here in England, the managers or heads of firms have seldom had any special training, whilst on the Continent those who have to direct the works have generally received a sound scientific education, supplemented by special technological instruction. Professor Thorpe tells us that in America the manufacturers are nearly all chemists; and, although they have not such good raw materials as we possess, "they are rapidly overtaking us in developing the manufacture of ceramics."*

It must be understood that it is very difficult to identify the individual industries which owe their special development to educational opportunities, and whilst in the report issued by the London County Council some three or four different trades are cited, in which such a causal connection has been established, these must be taken as typical only of other industries which have been created or improved through the far-sighted policy of the State, in liberally encouraging scientific research, and in affording every possible opportunity for the application of scientific methods to industrial process. Only recently there appeared in the *Times* a paragraph stating:

> "As evidence of Continental enterprise in engineering work, it may be noted that an order for thirty-two locomotives has recently been placed by the East Indian Railway Company with a German firm, who tendered a price nearly 20 per cent. lower, and for delivery nearly 25 per cent. sooner, than the English firm whose tender stood next."

At the railway works in Cairo, where contracts are made by tender, large quantities of machinery are supplied by German firms; and within a few weeks only of the proclamation of peace in South Africa, German agents were on the spot obtaining orders for machinery and tools, for which, without reference to the firms they represented, they were able to quote definite prices. Professor Ayrton, the well-known electrical engineer, states:

> "If you want a piece of electrical machinery constructed according to a well drawn out specification, do not send to an English firm. For dynamos,

* Report T. E. B., p. 4.

manufacturers send to Germany; for magnet steel, to Germany or France; for the material for resistance coils, to Germany, and for the paper used for insulating underground cables, to America." *

The great lesson which Germany and Switzerland have taught us has led to a developement of educational zeal in other parts of Europe; and although we in this country have been slower to profit by it than other countries, we are gradually awakening to the necessity of providing a more efficient training for all classes of the working population, and of giving to the select few, who are capable of usefully applying it, every opportunity of obtaining the highest university training. In the United States this enthusiasm for education has sunk deep into the spirit of the people, and as a consequence millionaires vie with one another in their efforts to establish and endow educational institutions, in which the youth of the country may obtain the most complete training for every conceivable career, and ample opportunities may be afforded for the prosecution of research.

Every engineer knows the extent of our dependence on America for some of our most useful machinery. Our shops as well as our technical schools are largely fitted with American tools, and we are in danger of suffering in this country not only from the superior inventiveness of our American cousins and their characteristic originality in grappling with commercial problems, but also from their ever improving facilities for all scientific experiments.

It is a fact which we cannot too soon recognise, that the main purpose of the enormous expenditure of first-class States on their naval and military services is the protection of their commerce and the increase of their trade; and except for home defence, this expenditure must be wholly unprofitable, unless the people are so trained as to be able to utilise to the best advantage the results which by force of arms have been secured. We, in this country, have spent during the last twenty-five years many millions sterling on war-ships which have never been in action, and most of which are now obsolete and of little use. The nation has not grudged that expenditure, knowing full well that our navy is our first line of defence, and that unless our shores and possessions are properly defended, war-like operations elsewhere cannot be successfully carried on. But it would seem that we have yet to learn that the ability to utilise for commercial ends the results of military successes depends very largely on the efficiency of our educational system, and on the special training of the people for industrial purposes. What that training should be is not yet definitely settled.

* Report T. E. B., p. 3.

It is a question of some difficulty, one that involves the consideration not only of school organisation, but also of the most suitable subjects and the best methods of instruction.

In a letter to the *Times*, August 5, on "The Military Education Report" Professor Armstrong truly says: "We now know that the most effective way of teaching young fellows to think for themselves is to give them real practical training in scientific method;" and if we are to have well-trained men, capable of initiating action, and of anticipating results, the aim of education must be to teach them "to think for themselves." To shew why it is that "training in scientific method" is the best discipline to this end, Professor Armstrong quotes Huxley:

> "The great peculiarity of scientific training, that in virtue of which it cannot be replaced by any other discipline whatsoever, is this bringing of the mind directly into contact with fact, and practising the intellect in the completest form of induction; that is to say, in drawing conclusions from particular facts made known by immediate observation of nature."

What strikes one most on comparing German with English education is its technical character. Education in Germany has been, up to the present time, a subject of more serious study than in England. It is an essential part of the nation's life, and is so organised as to bear directly upon the career and occupation of each individual. In this sense it is distinctly technical. Students in Germany do not flock to the universities to acquire a smattering of culture, nor to obtain that elementary knowledge of the classics which serves as a class distinction, nor even to rub off by contact with other students their essential angularities. They go there to study what will be useful to them in their future career, and they enter the faculty or department which affords the special training most helpful to their life's work. This is especially to be noted in the case of the sons of manufacturers, or engineers, or business men, who may be expected to follow in their fathers' steps. In this country the rich manufacturer's son goes to Oxford or Cambridge with no definite object, and enters upon a course of study that has no reference whatever to his future calling. This is not so in Germany. There, he acquires at the university or technical high school the special knowledge which has a distinct relation to his business; and, as a result, he learns to realise the importance of expert help, and is constantly watching for the opportunity of applying to the improvement of his trade any discovery or new invention which his technical knowledge suggests is worthy of the trial. The journals of scientific societies are carefully studied, and he maintains, either personally or through his staff of experts, a close and uninterrupted acquaintance with the published results of laboratory investigations.

Writers, and more frequently speakers, fall into a common error of supposing that equal facilities for the higher training, literary or scientific, do not exist in this country. The question is not so much one of facilities, as of appreciation of the importance of the higher education, of its training and discipline, and of the value of scientific method and investigation in every branch of industry.

It is true that we do not yet possess in this country any institution as well organised, both as regards its staff of professors and the equipment of its laboratories, as some of the technical high schools in Germany. In London there is none that can compare in these respects with the well-known school at Charlottenburg, Berlin. The higher technical education of London is wanting in co-ordination. Instead of having one central college, in which advanced teaching in all branches of engineering and chemical technology is concentrated, we find different institutions competing with one another for students, each imperfectly equipped, and all engaged in very much the same kind of work. As a result, whilst there is unnecessary over-lapping of facilities for training in certain sections of knowledge, there are other branches for which no opportunities of technical training are provided. It is hoped that in due time, as the University of London acquires a larger measure of control over the teaching institutions, this waste of effort will be avoided and the teaching resources of London will be economically combined. It may be as well to remind our readers that at Charlottenburg there are ninety-one professors, distributed over six departments, in addition to demonstrators and teachers, and that the number of students in the winter semester, 1901-2, was four thousand four hundred and forty-one.

The organisation of a central school of technology for the training of students in different branches of industry might be effected without any great outlay, by the addition to one or other of our existing institutions of those departments for which adequate provision has not yet been made, and by bringing together, with freedom to each to pursue his special work, the several distinguished professors who are now occupied in giving, in separate schools, almost identical courses of instruction. What is wanted in the higher education is the application to it of the economic principles of co-operation and division of labour. The mere existence of a great central school, properly equipped and organised, would indicate the importance of the higher technical education, and would help manufacturers and others to realise the value of science in relation to industry. There is no doubt that the size and prominence of the buildings which have been erected in many German

towns for the purposes of technical instruction, have had the effect of rivetting the attention of the people on the close connection between industry and science, and have thus helped to create a general appreciation of its value. Certain it is, that a far larger proportion of the industrial population of Germany graduate in the higher technical schools, and there is consequently a greater and more available supply of scientific experts for the different sections of manufacturing industry. Moreover, the period of training at a German university is generally much longer than in England, and the number of trained students qualified to take part in the higher branches of scientific investigation and research is undoubtedly greater, in Germany and in the United States, than in this country.

As regards the education of engineers, there is a growing opinion that the instruction given in our universities and technical colleges needs to be supplemented by concurrent practice in actual engineering work. There is a complaint that the teaching is too academic. The successful engineer must be of necessity a man of business. He must understand the commercial conditions under which work is carried out, and he should have acquired, at a comparatively early stage of his career, some familiarity with the different classes of work people, and a knowledge of how they are governed and controlled. For these reasons, several eminent engineers are of opinion that the present system of sending a youth to spend three years in the engineering faculty of a university, before commencing actual work, is not the best preparation for any branch of the profession.. Moreover, it is thought that the university terms, occupying on the whole not more than seven months of the year, are too short for the proper training of engineering students, and involve unnecessary breaks in their work. It has been suggested, therefore, that students in engineering should divide the session into two parts, and should spend six successive months in each year at the university or technical college, and the remainder of the year in engineering practice. This arrangement would certainly prove advantageous to the students, and might be equally so to the professors, who would thus obtain a continuous period of leisure for their own investigations or private practice. In Germany, many engineering firms receive students from the polytechnics during the long vacation, and the German student values very highly the practical experience which he is thus able to acquire during the period of his university course. But the system now suggested would be an improvement on that adopted in Germany. It would combine theoretical and practical teaching during the entire period of the student's ap-

prenticeship and, whilst enabling the professors to omit from their present courses some part of the collegiate workshop training, would leave more time for continuous instruction in the purely scientific subjects on which the practice of engineering is based.

This proposal, of which more will be heard later on, shows how necessary it is to approach the problems of technical education altogether free from the bias and the traditions of the old classical and literary training. The practice of the older universities, whether here or abroad, is no guide to what is best for the student who is to follow the calling of a manufacturer or engineer. The educational problem must be considered in relation to professional and commercial requirements. And it is essential that the commercial aspect of the question should not be lost sight of. What the country needs are business men with a knowledge of science and a just appreciation of its value as applied to industry—men who have been trained in the methods of investigation and research. Mr. A. G. Green, a well-known consulting chemist, says: "The most that can be hoped is to educate the rising generation of commercial men to a better appreciation of the value of science for the development of our industries."* To induce manufacturers to recognise the value of science in its application to industry, and to hold out inducements to science students to familiarise themselves with the ways of commerce, are the great desiderata for the improvement of our industries. The advice of Mr. George Beilby to the Committee of the London Education Board is worth repeating: "Increase the knowledge and respect for science of our business men, and develope in our students of applied science a corresponding respect for the business and economical aspects of industry." To give this twofold training should be the endeavour of the commercial and industrial faculties of our new universities and the aim of our higher technical education. I conclude this contribution to the study of the question of the industrial importance of technical education by a quotation from the report of the Royal Commissioners on Technical Instruction, which is as applicable now, as it was in 1884, when the report was published:

> "The Germans and Swiss have been and still are distinctly before us, not only in the facilities which they possess of obtaining the highest technical training in their numerous universities and polytechnic schools, but by what is even more to the point, in the general recognition of the value and importance of such training for the successful prosecution of any branch of applied science."†

* Report T. E. B., p. 39.
† Report, Vol. I., p. 225.

COST OF ENERGY IN ELECTRICAL SUPPLY.

By Alton D. Adams.

Exact data of costs are always useful and interesting to those who are studying the economy of production engineering. Mr. Parsons' study of the costs of electric energy from isolated plants, published in THE ENGINEERING MAGAZINE for January and February, 1902, has proved a work of permanent value worthy of reissue in book form; Mr. Adams to a certain extent supplies the complement to this work in the form of figures for large central stations.—THE EDITORS.

IGURES for the cost of electrical energy are scarce. It is easy to estimate the probable cost of energy at an electric plant operating during a fixed number of hours per day at full load, when desired conditions as to equipment, fuel, and water are assumed. But this is not the problem in systems of electrical supply. Managers of such systems are glad to learn the costs per unit of energy output elsewhere, but hesitate to name their own, for business reasons. A single State in the Union, Massachusetts, collects data as to the costs of electrical energy at the supply systems within its limits, through a commission; but these data are reserved to guide the commission in its regulation of the lighting companies, and are not published. In one instance, on Feb. 20, 1901, this commission made a specific statement covering the cost of electrical energy. This statement was in reply to an order from the House of Representatives, which directed a report on "the cost of manufacturing and distributing electric light." The answer to this order was a general statement, applying to no particular system, that the cost of manufacture varied from less than two to more than seven cents per kilowatt hour, and the cost of distribution from one to nearly six cents for the same unit. These figures are notable in the wide range of costs indicated, and may well lead to a consideration of the reasons for such variations.

Important among these reasons is the fact that existing systems of electrical supply represent a growth. It is easy to demonstrate that expenses of operation would be lowered, and efficiency raised, if the older generating and distributing equipments were replaced at once by others of the latest design. But such a move is impracticable for two reasons. In many cases funds are not forthcoming for such im-

provements, however desirable they may be. In other instances, while expenses might be lowered and efficiency raised by the adoption of the latest apparatus, the resulting increase of fixed charges would more than offset the possible saving in operation. Again, fuel, boiler and condensing water, and water power, vary greatly as to cost per unit in different locations, so that absolutely uniform equipments could not lead to equal results.

Through the range of capacities represented by the great majority of electric-lighting stations there is a strong tendency toward smaller costs of operation per unit of output as the plants grow larger. yet these plants must in general be limited in capacity by the demands of their service areas. The kinds of load carried, whether street or commercial lighting or service to stationary motors, as to their relative amounts, are far from uniform in different places, and this introduces another variable element in costs per kilowatt hour. Densities of electrical loads over their distribution areas are subject to wide variations, with consequent differences in expense per delivered unit.

The foregoing are some of the main factors that tend to varying costs per kilowatt hour in electric systems. Compared with a plant which is operating a fixed number of hours daily at full load, systems of electrical supply necessarily present a much higher cost per kilowatt hour. At a central electric station, the maximum load comes on and goes off rapidly and continues during hardly more than one hour daily. Compared with this maximum load, the minimum load is usually less than twenty and the average load less than fifty per cent. To meet these conditions with a steam plant, there must be fires under some of the boilers during several times the daily period that they are actually furnishing steam. Furthermore, the changing loads make it practically impossible to keep all of the operating engines at full load. If water power is employed to carry the entire load, some of the wheels must work at less than full capacity, and the space for water storage during a part of each twenty-four hours must be large, if the daily flow of water is not much greater than that necessary for the total output of energy. With either steam or water as the motive power the capacity of generating apparatus at the central station must be about double the average load.

In systems of electrical supply a large part of the cost of energy is added after it leaves the station. Not infrequently the cost of energy at dynamo terminals is increased fifty to seventy-five per cent. by the time it reaches the premises of consumers. The investment in distributing lines and apparatus outside of central stations is often as

great as the investment in all the generating equipment inside, both steam and electric. Besides the interest, depreciation, and repair charges on this outside apparatus there are important labor charges incident to its regular operation.

In view of the foregoing facts it is clear that experience is the only reliable guide to the cost of energy in electrical supply. Costs per kilowatt hour here given are derived from annual expenses of operation by dividing the totals by the numbers representing the yearly outputs in kilowatt hours. Systems to which the results relate vary several hundred per cent. in their annual outputs of energy; a part use steam as their only motive power, and the others drive electric generators with water power alone or with water and steam combined. In every case, except one, it has been possible to separate operating expenses into those at the generating station, those of distribution, and those covering management, taxes, and incidental expenses. Station expenses include only the labor and materials actually consumed there in operation and repairs. Expenses of distribution cover the labor and materials employed in the operation and repairs of the lines and other apparatus that completes the connection between the generating station and the local circuits of consumers, also the cost of collection. Management and incidental expenses include all sums paid to officers of the electric companies, the hire of clerks, and general office expenses.

All of the costs here given, except the first case, relate only to the management, operation, and repairs of electric systems and include nothing for depreciation, interest, or dividends. These last named charges are omitted entirely, because they vary greatly in different systems, and are largely regulated by financial policies and personal opinions.

During a recent calendar year, a certain electric station driven entirely by water power delivered more than five-million kilowatt-hours of energy for use in a system of electrical supply. This energy was sold to the supply system at a rate which must be presumed to have covered interest or dividends and depreciation as well as operating expenses. The total cost of this energy to the electrical-supply system, delivered at its sub-station, was almost exactly 0.4 cent per kilowatt hour. This rate includes nothing for distribution, management, or incidental expenses on the part of the supply system. The figure just given seems to represent the total cost of electrical energy from a rather small water power when transmitted less than a score of miles, and a moderate return on the investment besides.

The next case is that of an electrical-supply system which delivered

somewhat more than three-million kilowatt hours to consumers during a recent year. More than 70 per cent. of this energy was derived from water power by a transmission of less than ten miles, and the remainder was developed by steam power. For this supply system the total cost of energy was 3.85 cents per kilowatt hour, covering every expense of operation. At the generating stations alone the cost of delivered energy was 1.75 cents per kilowatt hour. Distribution added 1.26 cent to the cost of development, and the sum of expenses for taxes, management, and incidentals was 0.82 cent, raising the total cost per kilowatt hour to the figures named. The system to which these data apply has in the main a first-class equipment, is managed with ability, and supplies light and power in a prosperous city. It should be noted that the system just considered comes within the lowest figures named by the Massachusetts commissioners for the cost of energy at electric stations, that is, less than two cents per kilowatt hour, and is nearly down to the one cent per unit named by the same authority as the lowest cost of distribution. For the amount of energy yearly delivered the cost per unit in this system is exceptionally low, due in part no doubt to the large percentage developed by water power.

Unlike the foregoing, the following supply system develops all of its energy with steam power. Data covering costs per kilowatt-hour in this system are presented for three recent successive years. During the first two of these years the output of the system was about one and one-half million, and during the last of the years a little under two and one-half million kilowatt-hours.

	At Station.	For Distribution.	Management, Taxes and Incidentals.
First year	2.30	1.95	1.27
Second year	2.18	1.57	1.49
Third year	2.21	1.58	1.06

COST PER KILOWATT HOUR, IN CENTS.

In the first year for which the data of costs are given, this electrical system represented many features which it is desirable to abandon. All engines at the generating station were then of the simple type, and operated non-condensing. A constant supply of fresh feed water from city mains was required for the boilers, and no economizer was in use. Electric generators of four different types and voltages were belted to engines or shafting, and delivered energy to four sets of distribution lines. In that year a change to economizers, condensing engines, and direct-connected electric generators of a single type and voltage began, and has only recently been completed. In the main the figures for the costs of energy show the lowering tendency of these

changes, though results have been retarded by extra labor of operation during the gradual reconstruction. It is probable that the year next after the third given will show further material reductions in the costs at the station and for distribution. Viewing the three years, the cost per unit of energy at the station has come down 4 per cent., for distribution 20 per cent., and for management and incidentals 16 per cent. The total reduction has been from 5.52 cents to 4.85 cents per kilowatt hour.

Compared with the system before mentioned, which derived more than 70 per cent. of its energy from water power, this steam system, in the third year, delivered about one-third less energy. Nevertheless the cost of energy at the station of the steam system was only 0.46 cent more per kilowatt hour than the like cost at the stations of the larger system. Distribution necessarily costs more per unit at the smaller system independently of the amount of delivered energy, because its area of distribution is much larger.

Station capacity and the annual volume of delivered energy are not always great where the cost per kilowatt hour is low. An example of this sort is found in a small system of electrical supply that delivered a little less than one half-million kilowatt hours during the year ending June 30, 1901. It should be noted that the annual output of energy by this small system is less than one-seventh of that by the larger and about one-fifth of that of the smaller of the two systems last considered. This small system depends entirely on steam for a motive power, and its single station operates with belted engines and dynamos that deliver current at three voltages to as many separate sets of distribution lines. No economizers are used here, but the engines run condensing. Cumberland coal at this plant costs $3.50 per long ton delivered in the bins. Condensing water was obtained from a private source. In spite of its disadvantages of small capacity and antiquated equipment, the cost of energy to this small system during the year named was only 4.47 cents per kilowatt hour for manufacture, distribution, management, and incidentals. This cost is only 0.62 cent larger than that for the system that delivered more than three-million kilowatt-hours, and is 0.39 cent smaller than that in the system that delivered more than two-million kilowatt hours per year. As might be expected, the small system makes its poorest showing at the generating station, where the cost was 3.12 cents per kilowatt hour. This cost is nearly twice as great as that in the system where both water and steam power were used, and is nearly 50 per cent. greater than the station cost for the large system using steam power only. An equipment of direct-

connected units of uniform type and voltage, together with an economizer, would materially reduce this rate of 3.12 cents per kilowatt hour. About 8 per cent. of this rate is made up of a sum paid for current purchased from another system, because the station capacity was not sufficient at certain times. In the matter of distribution this small system is favored, its load being confined to a relatively small area, and the cost of distribution was only 0.46 cent per kilowatt hour, or less than one-half and one-third respectively of the like costs in the other two systems. Management and incidental expenses for the small system were only 0.87 cent per kilowatt hour, or between the two like costs previously named.

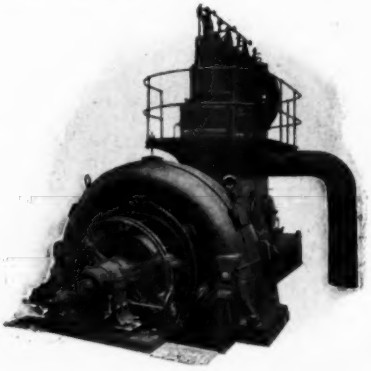
Yearly output of energy in kw. hours.	At Station.	For Distribution.	Management and Incidentals.	Total.
Between 3 and 4 million.....	1.75	1.26	0.82	3.85
*" 1.5 and 2 "	2.30	1.95	1.27	5.53
*" 1.5 and 2 "	2.18	1.57	1.49	5.26
*" 2 and 2.5 "	2.21	1.58	1.06	4.86
" 0.4 and 0.5 "	3.12	0.46	0.87	4.47
" 5 and 6 "	0.40	Purchased from water-power station.		

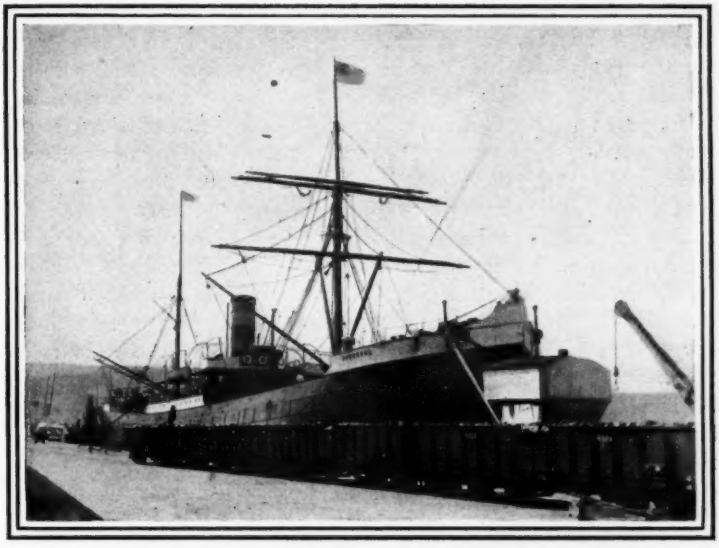
* Same system in three successive years.

COST OF ENERGY TO SEVERAL ELECTRICAL SUPPLY SYSTEMS, IN CENTS PER KILOWATT HOUR.

A tabular recapitulation of the data for the several systems.

The foregoing data show how impossible it is to lay down any fixed rule for the fixed cost of energy in systems of electrical supply, because of variations in other factors as well as size. No doubt it can be demonstrated by figures that systems with the annual outputs named might deliver energy at lower costs. The only merit claimed for the present data is that they accurately represent results actually reached in practical electrical supply.





THE STARTING POINT OF THE NATAL GOVERNMENT RAILWAYS AT DURBAN.

THE RAILWAY SYSTEM OF NATAL.

A SPECIAL INTERVIEW WITH THE HON. SIR DAVID HUNTER, K.C.M.G., GENERAL MANAGER OF THE NATAL GOVERNMENT RAILWAYS.

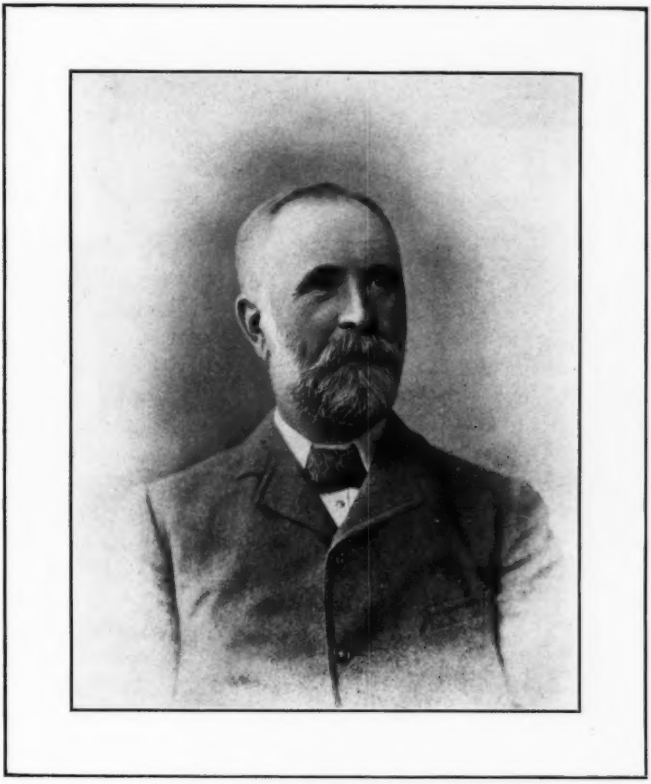
By J. Hartley Knight.

There are two important factors likely to influence the development of South African railways. First stands the lately reported discovery of new gold areas, rivalling in size and importance the already known reefs. Second is the possibility mentioned by Mr. John Hays Hammond in these pages in July last—that with irrigation the Transvaal would become highly fertile. It is not inconceivable that, as in the case of California, the movement of agricultural products might in the end exceed in traffic importance the railway business provided by the mines. In any case, the railways of Natal seem certain of great activity and expansion during the next few years, and this gives interest and importance to Sir David Hunter's views as obtained and recorded by Mr. Knight.—THE EDITORS.

"SO long as we make and manage the railways I care not who makes the law," observed the general manager of the Natal Government Railways—Sir David Hunter—when presiding, in 1897, at an important conference of the executive heads of the South African railway systems. The remark is not only characteristic of Natal's "Railway King," but it also illustrates the spirit which the leading men of the Garden Colony have ever displayed in their determination to advance and uphold the interests of their portion of the great

sub-continent, and which has made their colony a model of its kind to the rest of "Darkest Africa." There is no gainsaying the fact that for its size the colony has shown a wonderful amount of enterprise in all that pertains to the progress and welfare of its people; and it must never be forgotten that the iron horse made its first appearance in Africa on the hospitable shore of fair Natal. Of that important fact, indeed, Natalians are not a little proud, and naturally so. Forty-five years have elapsed since certain far-seeing men of Natal came to the conclusion that a railway was essential to the welfare of their colony, and three years later, in 1860, the shrill whistle of the locomotive was heard for the first time in Durban, or, as it was then more generally termed, Port Natal. The line was—like the immortal Jack Easy's wet nurse's baby—"a very little one." To be exact, it was less than two miles in length and it ran from the Point—situated at the base of that bold headland locally known as the Bluff—to the town of Durban. The line was constructed and run by the Natal Railway Company; and I am indebted to Mr. J. Forsyth Ingram for the statement that it was worked under difficulties "which can scarcely be realised at the present time." Some years elapsed before the Point Line began to show a margin of profit. It is interesting at this length of time to recall that for the half-year ending December 31st, 1868, the liabilities of the Natal Railway Company were returned at £13,695 14s. 5d., that their gross revenue amounted to £3,815 1s. 7d., and their gross expenditure to £3,005 1s. 1d., showing a net profit of £810 0s. 6d. Thereafter, as the liabilities of the company decreased, the revenue and profits rose in proportion, and in the half-yearly report to the 31st December, 1874, we find the following results: Liabilities, £2.389 11s. 4d.; gross revenue, £11,116 15s. 2d.; gross expenditure, £6,499 10s. 7d.; net profits, £4,617 4s. 7d. To have made a profit of less than £5,000 after 14 years' working is not perhaps a cause for very much trumpeting—but be it remembered that the line whence this profit was derived was only two miles in length and was after all little more than a toy, though it served a very useful purpose.

Evidently the difficulties which Mr. Ingram hints at were to some extent responsible for the fact that so long a time went by before a start was made to metal the distance which intervened between Durban and Pietermaritzburg, the capital, a matter of 71 miles. That a railway between the two towns was badly needed there is abundant evidence to prove. The first sod of the new extension was ceremoniously "turned" in 1876—that is, 16 years after the opening of the line from the Point to Durban. Amid a tremendous burst of cheering "the sod



SIR DAVID HUNTER, K. C. M. G.
General Manager Natal Government Railways.

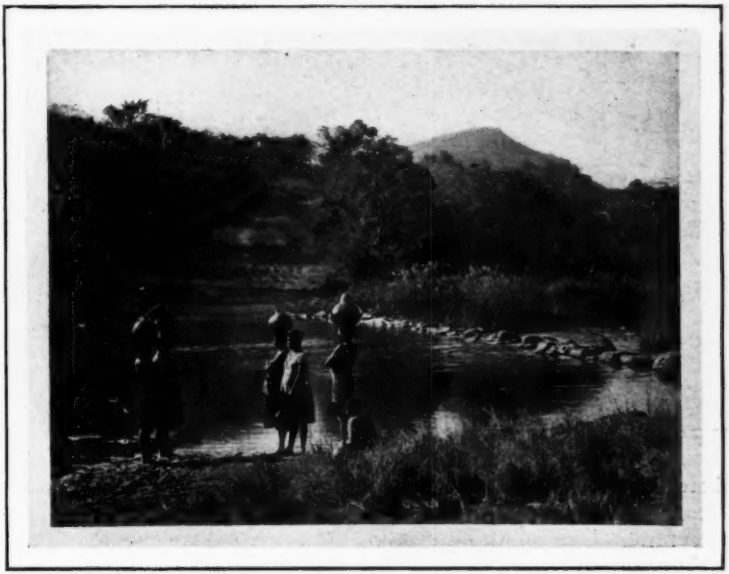
was cut and turned and trundled and finally pitched out of the new barrow back again upon the dusty soil, all in the most artistic and satisfactory condition."

Some three years after this auspicious occasion there proceeded to South Africa a young man who had shown such marked ability as assistant general superintendent of the North British Railway that the then Secretary of State for the Colonies in the British Cabinet appointed him general manager of the Natal Government Railways, which had absorbed (as will presently be told) the Natal Railway Company. The British ministers who have successively "bossed" the colonies from Downing Street have occasionally displayed a lament-

THE MAIN WHARF, DURBAN, LOOKING NORTH.

able ignorance of the requirements of their oversea *protégés,* but it is to the eternal credit of Sir Michael Hicks-Beach that he gauged the necessities of Natal and sent the colonists the right man in the person of Mr. David Hunter to look after their railway affairs. It is not flattery but simply the honest plain truth to say that Sir David Hunter has made the railway system of Natal what it is to-day, viz., a model for other colonies to emulate, if not to equal. Quite recently—on the day before the Coronation solemnity in Westminster Abbey, whereof he and Lady Hunter were honoured spectators—I had the special privilege of discussing Natal railway matters with the gentleman who so largely controls them. I desire at this stage to express my great obligations to Sir David Hunter for so courteously and good-naturedly consenting to be interviewed at a time when he obviously needed rest after a long and fatiguing night journey by train from Edinburgh, to which city he returned almost immediately after the ceremony in the Abbey, there to enjoy the remainder of the holiday granted him after the immense strain which was imposed upon him in Natal during the recent Boer campaign. I found it hard to induce Sir David Hunter to talk about himself; instead, he preferred to speak of the Natal Railway system. To a large extent the two subjects are synonymous.

"I first went to Natal in 1879," said Sir David, "having been appointed, as perhaps you know, by the gentleman who was at that time Secretary of State for the Colonies. This was a couple of years after the Natal Government had acquired from the Natal Railway Company the line from the Point to Durban—which had been running for some years—and thence to Umgeni, about five miles altogether. The Natal Government had taken up the question of railway construction in real earnest. The first railways constructed under their direction consisted of a line from Durban to Maritzburg, another from Durban to Verulam (20 miles) and a third, of only 7 or 8 miles, from Durban to Isipingo, on the South coast—in all about 100 miles. The construction of these lines was commenced simultaneously. The line to Maritzburg was completed in 1880 and the opening ceremony was performed at Maritzburg Station by the then Governor, Sir George Pomeroy Colley, who was afterwards killed at Majuba in the first Boer war."



A RIVER CROSSING IN NATAL.

"The arrival of the iron horse in Maritzburg was doubtless an incentive, Sir David, to go ahead with railway extension in other directions?"

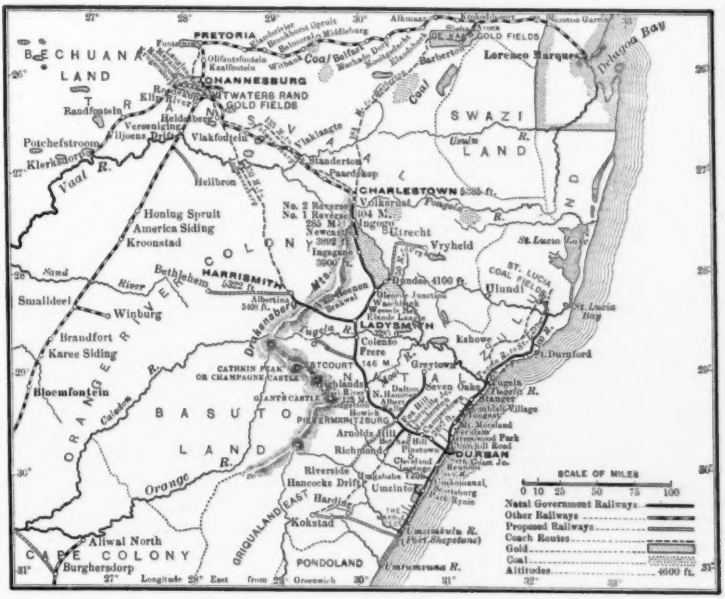
"It was. After the line to the capital was in working order fresh railway extension was projected, and the next section beyond Maritzburg, in a northerly direction was commenced. Howick and Estcourt were reached and the line ultimately stopped at Ladysmith. The wark of extension beyond Ladysmith was performed in a somewhat fragmentary fashion, if I may so express it, governed by the financial circumstances of the Colony. The first section was one of 17 miles and extended to the now historic field of Elandslaagte. It was afterwards extended to Glencoe junction—whence a branch line goes to Dundee —and subsequently to Charlestown, the most northerly point of Natal. The line to Charlestown was opened for traffic in 1890 in the presence of Sir Charles Mitchell, then Governor of Natal (after whom the little

THE RAILWAY STATION AT MARITZBURG.

border town was named), who was attended by the members of the Executive Council, of which at that time I was one. There were great rejoicings on that occasion. His Excellency met President Krüger at Borderspruit, that is to say in Transvaal territory, and the old gentleman"—I acquit Sir David of any sinister intention in the term—"was accompanied by a large number of his principal officers. The whole company were conducted to Newcastle and to Maritzburg and, later on, to Durban, where great festivitiès were held. You may

be interested to know that on that occasion it fell to my lot to present 'first' tickets—which were numbered 0000 as 'first' tickets usually are —to Sir Charles Mitchell and to Mr. Krüger, a 'single' to the former and a 'return' to the latter. These tickets were of gold and the back of each bore a suitable inscription.

"But this completion of the Natal line to Charlestown did not mean through connection with Johannesburg. The extension of the



NATAL GOVERNMENT RAILWAYS AND CONNECTING LINES.

line from the Natal border to the Rand is a long story, and was not accomplished until after much wearisome discussion with President Krüger in Pretoria, in which I was always one of the delegates. In the first instance I accompanied Mr. F. Seymour Haden, C.M.G. (Colonial Secretary of Natal), but on the two subsequent occasions my colleague was Mr. (now Sir) Thomas Murray, then Minister of Lands and Works under Responsible Government. The conference took place as I have said in Pretoria and on the last occasion we made a stay there of several weeks." [Sir David did not add that Mr. Krüger, like Pharaoh of old, had hardened his heart to the delegates' representations so persistently that their souls almost sickened at his stubborn-

HYDRAULIC CRANES AT WORK ON THE MAIN WHARF, DURBAN.

ness, but it is a fact nevertheless.] "At last, however, we came to terms with the President and on February 3d, 1894, we entered into an agreement with him whereby we undertook to extend the line from our border to Johannesburg. The extension was completed and the line opened for traffic in October, 1895. It is a fact that the actual construction of the line in the Transvaal was carried out by the Government of Natal, the general manager (that is, myself) representing them as the contractor for the work, and the agreement being signed by myself and the chief engineer of the Netherlands-South African Railway Company. When the rails were joined up at Heidelberg there was a formal gathering followed by a luncheon, at which were present Doctor Leyds, representing President Krüger, and Sir John Robinson, the first Premier of Natal. During the latter's term of office, a new

departure took place in the construction of cheaper railways than the main line—although still adhering to the standard gauge of three feet six inches—and extension took place both on the north and south-coast routes, the former ultimately reaching the Tugela River and thence running for another 100 miles to the St. Lucia coal fields in Zululand which is now, as you know, a province of Natal. On June 30th last the rails of this line were within 15 miles of a terminus at St. Lucia Bay, and on the 20th of July about 50 miles of the line were formally opened for traffic.

"There is hardly any doubt that this extension will be of great assistance to the development of Zululand. As I have said, about 100 miles in all are being constructed in Zululand, and these will form a very great feature in the opening up of the country, which has hitherto been almost entirely a black-man's land but will no doubt be opened to European settlement. On the south coast of Natal the line has been extended to Port Shepstone on the banks of the Umzimkulu River, about 70 miles from Durban. From the Umzimkulu it is proposed to construct a line towards Kokstad and North Pondoland."*

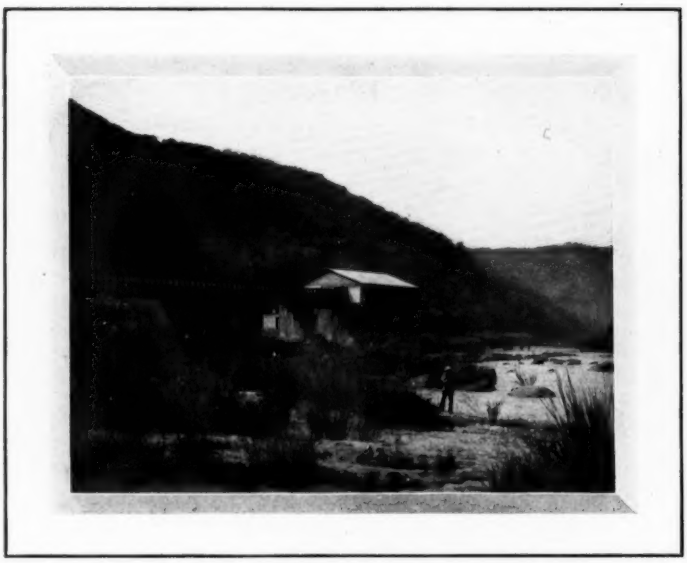
"Then there is the line which will directly connect Natal with the Cape Colony—how does that stand, Sir David?"

"The extension from Maritzburg to Riverside has already been commenced. It consists (so far as the Natal portion is concerned) of about 100 miles of railway, and already some 25 miles are under construction. The Cape, although pledged to undertake this connection, has not yet taken the necessary steps—in so far, that is, as actual construction is concerned."†

Whilst on the subject of railway extension I desired to elicit from Sir David Hunter some expression of opinion on the big undertaking which is shortly to engage the attention of a special session of the Natal Legislature, viz., the doubling of the existing main line to Johannesburg or the construction of a new alternative route thereto. Sir David, however, could not yet say which of the two schemes was, in his opinion, the better one, explaining that extensive surveys are now going on, the result of which is not yet known; and I passed on to the subject of the engineering difficulties which had presented themselves in the construction of the existing lines.

* The total mileage now open in the colony is 660—about 140 miles more are under construction and, as indicated, a number of other extensions are in progress.—J. H. K.

† A Reuter's telegram, dated Durban, Aug. 3, says:—"Capital progress is being made with the construction of the Cape Natal Railway. The route has been pegged out as far as Umkomaas, and several survey parties are at work. Some of the country through which the line passes is of a most difficult character."—J. H. K.



ELECTRICAL POWER HOUSE ON THE UMOOTI RIVER.
Connected with the tea factory on the Kearshey Estate.

Natal is a very beautiful country and has every claim to the proud title of "the Garden Colony"; few, I think, will dispute that. But from the engineering standpoint it presents difficulties which are if not absolutely insuperable, at least not easily surmounted. The history of the recent Boer war has made that fact pretty common knowledge by now, I fancy. Quoth Lady Barker in reference to the extension from Durban to Maritzburg: "How the railway is to drag itself up and round all these thousand and one spurs running into each other, with no distinct valley or flat between, is best known to the engineers and surveyors who have declared it practicable. To the non-professional eye it seems not only difficult, but impossible." There we have the matter in a nutshell, so to speak; and a glance at the map on page 193 will show that railway construction in Natal is largely composed of gradients, and gradients, and again gradients—with now and again a magnificent curve of really appalling radius. A man in South Africa once told me that they dare not run long trains in Natal lest the heads and the tails thereof should collide with each other when negotiating the curves say, between Durban and Maritz-

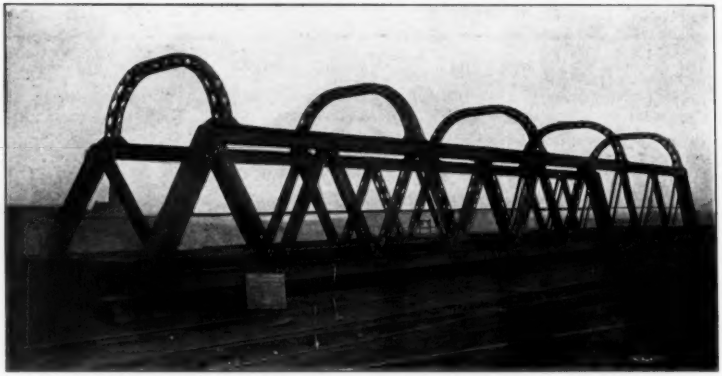
burg. How steep are the gradients will be gathered from the statement that the main line reaches an altitude of 3,054 feet above sea level at a point 58 miles distant from Durban, and that at a point 134 miles from that seaport it rises to a height of 5,152 feet, only to drop again another 55 miles further on to 3,284 feet. At Charlestown, in the extreme north of Natal, the altitude is 5,380 feet; and at Van Reenan, in the Drakensberg Mountains, where the line passes from Ladysmith to Harrismith (in the sometime Orange Free State) the line rises to a height of 5,520 feet.

"From the uneven character of the country," observed Sir David Hunter, when I raised the point, "Natal presents many difficulties in railway construction, and the earlier policy (when the colony was poorer than it is now) consisted of constructing lines over practically the contour of the country and the adoption of very severe gradients. The ruling gradient of the first section of the Natal line was 1 in 30, with curves of 300-feet radius. It is not seldom that these conditions are found in combination. As the result of experience and better circumstances the colony is now trying, although at greater first cost, to construct lines with easier gradients, and the newly constructed lines

REVERSING POINTS ON THE DRAKENSBERG MOUNTAINS.

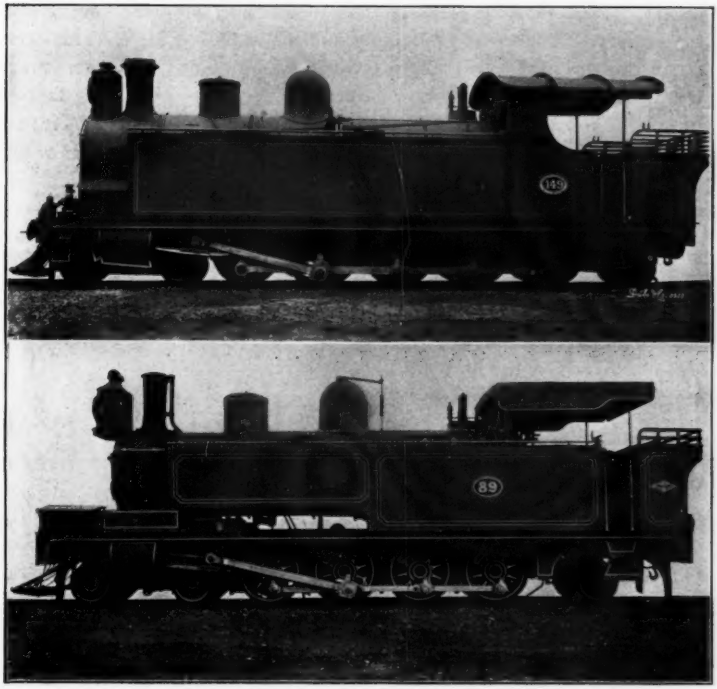
in the vicinity of Ladysmith have a gradient of 1 in 50. In regard to the matter you mentioned just now, viz., the doubling of the present main line to Johannesburg or the laying of an alternative rail from the coast, account will be taken of the existing conditions as to gradients, so as to obtain railways having better physical advantages, in order that the colony may be enabled to work the expected large through traffic to the Rand more economically than is at all possible under the present severe conditions.

"One special feature of the Natal railways coastwards is the very large proportion of iron bridges. This is occasioned by the number of rivers which flow into the Indian Ocean, most of which have lagoon mouths that close up during our winter and are crossed—often at very considerable length—by screw-pile iron bridges. This particular form of bridge was introduced at the time of the first construction by Mr. M. W. Carr, then engineer-in-chief of the Natal Government Railways, and it has been found to answer very satisfactorily. As a point of interest I may mention that on the South Coast line of 70 miles there are, I think, something like five miles of screw-pile iron bridges."



100-FOOT BRIDGE SPAN FOR THE NATAL GOVERNMENT RAILWAYS.
Erected by the Patent Shaft & Axletree Co., Ltd., Wednesbury, 1890.

I next broached the subject of rolling-stock. To understand what follows "without prejudice" the American reader should be told that Natal is perhaps more British in its sympathy and sentiment than any other colony on the entire African continent. Three-fourths of the white folk in Natal glory in the fact that they are of British origin, and they are resolved, as far as in them lies, to foster trade with Great Britain and Great Britain's colonies, to the exclusion, of course, of foreign competitors. But it is only fair to state that notwithstanding



LOCOMOTIVES OF THE NATAL GOVERNMENT RAILWAYS.

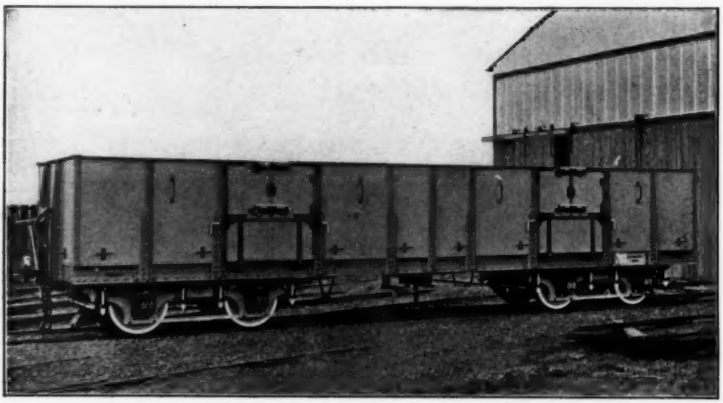
The lower one is the "Dubs" engine, eight-wheel coupled, weighing 48 tons in running order; the upper is the latest type of "Reid" pattern, ten-wheel coupled, weighing 73 tons.

this patriotism the average Natalian is able, like Shakespeare's Beatrice, to "see a church by daylight" and he never lets his pocket suffer —seriously so, that is—at the expense of his patriotism. In a word, he realises as Mr. Joseph Baynes, C.M.G. (a member of the Natal Legislative Assembly),* lately remarked to me, that "business as business knows no philanthropy—business as business knows no patriotism." That admirably expresses the attitude of the average Natalian.

"All our material has been obtained from British manufacturers," said Sir David Hunter. "It is rather an interesting fact that the railway system of Natal is equipped in every particular with motive-power and rolling-stock of British manufacture. We have never tried American locomotives; we have adhered to our own types, which have always been followed out in a progressive spirit. The original engines

* And an earnest advocate for the general extension of light railways in Natal.—J. H. K.

on our railway system were 25 tons weight and were capable of conveying over the steepest grade only 30 tons of paying load. The latest development is the 'Reid' engine, which weighs 69 tons, has ten coupled wheels, carries 3½ tons of fuel, and conveys over the steepest grade 120 tons of paying load. In this connection," Sir David Hunter added, "I have just been reading in the English press what one of the Metropolitan companies is doing to obtain a locomotive which will start and stop more quickly their suburban trains, and it is rather no-



HIGH-SIDED 30-TON TRUCK, NOW BEING SUPPLIED.
By R. Y. Pickering & Co., Ltd., Wishaw.

ticeable that the features of the locomotives adopted with that view are those which the Natal authorities are using and which were only adopted by them after a great deal of inquiry and experiment to secure the greatest amount of adhesion and tractive powers. It is, I may add, the heaviest engine on a 3 foot 6 inch gauge in the world."

"Harking back a moment, Sir David, to the subject of American locomotives. You have no prejudice against them in Natal?"

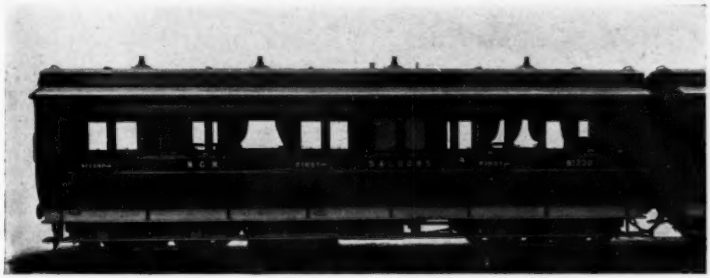
"Oh, not in the least. With us in Natal it is not a matter of prejudice or even of sentiment, but simply that we as practical railway men have thought it better to advance along the lines of our existing types of engines, and we have achieved splendid results in this way."

"It is open to American firms to tender for your rolling-stock as well as any other firms?"

"Certainly. We put out indents in the hands of Sir Walter Peace, the agent-general in London here, and he invites tenders in the usual way. Now and again, it is true, in times of pressure we have ordered

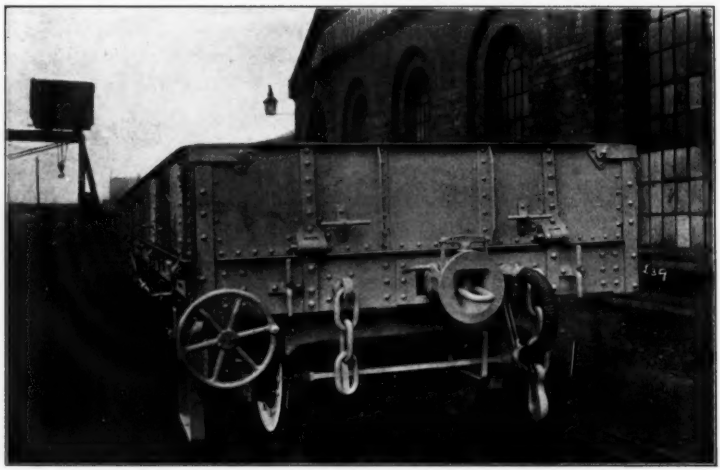
engines direct of firms which had previously supplied us with these —but these have been exceptional instances. There is nothing to prevent American firms from tendering in the ordinary way."

I find I have exceeded the limit to which this article should run and I must necessarily curtail what still remains to be written. In my opening remarks I have quoted statistics showing the earnings of the Natal railway in its early stage of existence. For the purposes of comparison it is interesting to recall that the total revenue for the year 1901 amounted to £1,650,355 5s. 4d., as against £1,242,280 15s. 9d., for the preceding year, showing an increase of 32.85 per cent. in comparison. In his last-issued annual report Sir David Hunter tells us that the working expenditure of the year (1901) amounted to £1,159,026 7s. 9d., "being an increase of 30.07 per cent. as compared with the preceding year, and includes £159,327 18s. 11d. expended upon additions and improvements which have been made to buildings, ways, and works, in order to cope more efficiently with traffic developments." The net revenue, after deduction of the working expenditure as explained, amounts to £491,328 17s. 7d., which, upon the capital applicable to open lines for the year of £8,528,989 gives a return equal to

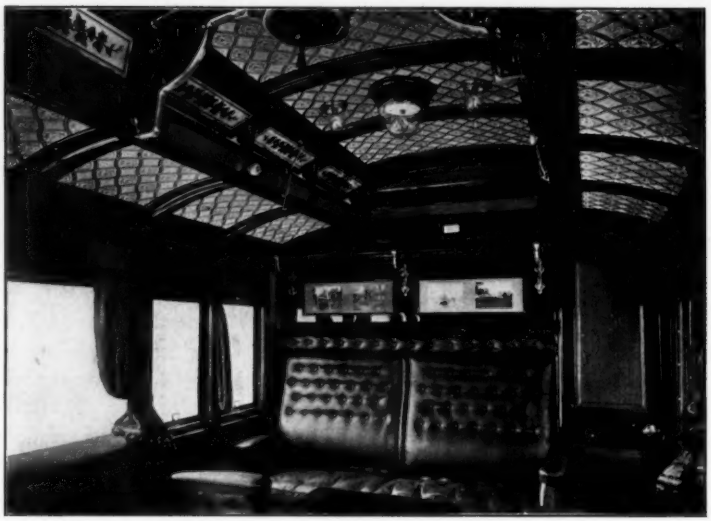


SALOON CARRIAGES IN USE ON NATAL GOVERNMENT RAILWAYS.
Bristol Wagon and Carriage Works Co., Limited.

£5 15s. 2½d. per cent., as against £4 9s. 11½d. per cent. earned upon the capital of the former year. In this report Sir David Hunter refers in graceful terms to the retirement of Mr. M. W. Carr, M. I. C. E., after 26 years' service, the last five of which were spent in London in the capacity of consulting engineer. Sir David expresses his "deep sense of the important services rendered to the colony by Mr. Carr in the construction and development of our railway system." Mr. Carr's place in London, by-the-bye, has been taken by his friend, Mr. H. G. Humby, M. I. C. E., who has seen many years' service in the Garden Colony, and who is eminently qualified to fill so responsible a position.

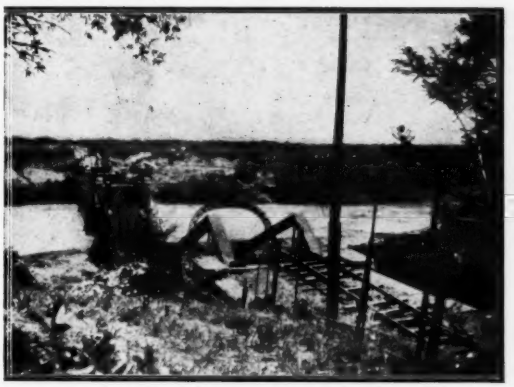


20-TON TRUCK, WEIGHT 9¼ TONS. IN SERVICE ON NATAL RAILWAYS.
Birmingham Railway Carriage & Wagon Co., Ltd.



INTERIOR OF SALOON CARRIAGE, NATAL GOVERNMENT RAILWAY.
Supplied by the Bristol Wagon & Carriage Co.

Natal's services to the Imperial cause during the campaign now happily ended will go down to posterity as one of the brightest features of a truly lamentable war. Never before had Sir David Hunter such a chance of proving the grit of the splendid fellows he controls. The late Major-General Penn-Symons, Lieut.-General Sir George White, General Sir Redvers Buller, Earl Roberts and Viscount Kitchener have successively borne high testimony to the excellence of the arrangements for the handling of the enormous traffic on the Natal lines during a period unique in the history of any country in the world.



DESTROYED BRIDGE OVER THE TUGELA RIVER AT COLENSO.

Illustrating some of the difficulties of railway management on the Natal lines during the Boer war.

Very heavy indeed was the demand made upon the Natal reconstruction department, but they answered to the call with a promptitude which is beyond praise, and which many an old Anglo-African of my acquaintance has declared was possible only in Natal, and which certainly was worthy of the colony which first had the honour of introducing the iron horse into Africa. No wonder Lord Kitchener in a recent dispatch acknowledges "with gratitude" the obligations under which the army in South Africa have been placed by the "ungrudging assistance" given to his lordship by, among others, "Sir David Hunter, K.C.M.G., and the staff of the Natal Government Railways."

THE UTILISATION OF THE PEAT FUELS OF EUROPE.

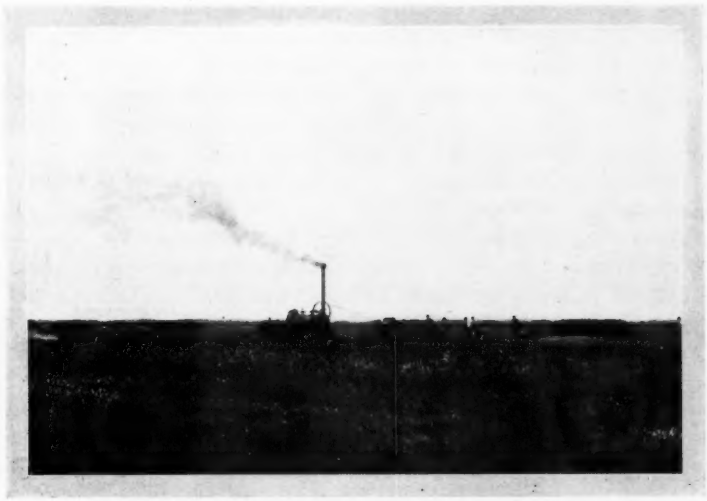
By Adolf Dal.

While primarily of importance in countries where the cost of labour is low and the necessity for economy is acute, the use of peat is not without its industrial significance. It is reported that even in the eastern United States, resort has recently been had to peat fuel under pressure of famine prices for coal. The suggestion of its more extended use by the establishment of a power plant close to the source of supply, with power-distribution thence by means of fuel gas or electricity, is particularly interesting and in direct line with the best modern practice in the economical utilisation of natural resources.—The Editors.

EAT has long been used as fuel; in Germany especially its use dates back so far that the ancient Roman naturalist, Pliny, tells us that that Teutonic tribe on the borders of the North Sea dried and burned "mud" (peat). Its more extensive use dates from the middle of the last century, when fuel for steam engines was required on a larger scale; and in very late years, high prices of coal have attracted renewed and most active attention to the use of peat fuel.

The bogs in which peat is contained cover extensive areas in the northern temperate latitudes, both in Europe and in America. In Germany they cover nearly 30,000 square kilometres, and in Ireland, according to Lyell, they cover the tenth part of the country. The depth is very variable, but is on an average 5 to 7 metres and more; thus in Ireland bogs are found with a depth as great even as 15 metres. It may be estimated that one square kilometre of 5 metres depth will give about 700,000 metric tons of dried peat; hence it will be seen that the amount of fuel in these bogs is enormous.

Peat is all organic matter, formed from mosses and other minor plants, which have been submerged in water and thus preserved in the bogs. As it exists in the bogs, the largest constituent is water, dry matter forming only about 10 per cent. of the total weight. When peat from the bogs is used for fuel, therefore, much water must be removed and this forms a great difficulty in the manufacturing. In fact, the drying of the peat is everywhere regarded as the most troublesome point, for it is impossible to remove the water economically in any artificial way, either by pressure or by heating in kilns or kiln-like



PEAT-MILLING MACHINE AT WORK ON THE MOORS OF OLDENBURG.

appliances; the peat must be dried in the open air, and the preparation thus becomes much dependent on the climate. In level open countries, however, where the wind is constantly blowing, the the drying in ordinary years will be very well performed. In almost all districts the peat is spread out to dry in the open on the levelled and evened surface of the bog; only in certain very rainy countries, as in southern Bavaria, Styria, and in western Norway, shelters are sometimes used. Peat dried in the air will hold about 20 per cent. of water.

The most ancient method of digging peat, still much used, is the simple one of cutting it by hand with a spade in regular, rectangular pieces, which are then spread on the levelled surface of the bog and dried. At present this method is much used in the Netherlands and in Germany. Although it requires much labour, yet it will often give a very cheap fuel, especially where wages are low, a skilled labourer being able to work one metric ton of dried peat in a day. Probably the larger part of the peat produced in the countries just named is such "cut peat." But as wages grow higher this method will tend to fall into disuse.

Cut peat, however, is of somewhat loose consistence and has an excessively large bulk, a hectolitre of it weighing on an average 20 kilogrammes (12 pounds to the cubic foot). As it takes two pounds of peat to equal one pound of ordinary coals, it will be seen that eight

cubic feet of cut peat must be used to equal one cubic foot of coals. Hence it follows that transportation will be costly, and store houses and fire rooms must be very large where this peat is used.

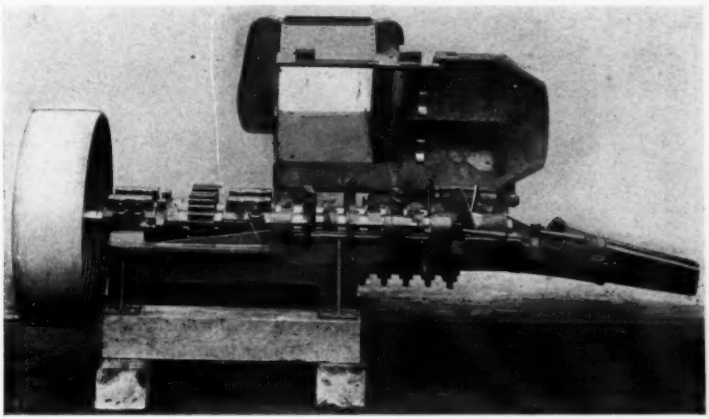
In order to reduce the volume, peat-milling machines have been commonly introduced into all European countries within the last fifty years. In these machines the fibrous structure of the peat is broken up, the mass kneaded, mixed, and somewhat pressed together; it contracts considerably in drying, the volume of the dried peat often being only one-eighth of the original. Thus the peat gains a very compact consistence, and bears a close resemblance to lignite, both in appearance and density. The specific gravity often surpasses that of water; most commonly its weight is about 40 kilogrammes per hectolitre (30 to 40 pounds to the cubic foot). In this form the peat may be transported, its weight giving a full waggon load. Nor is the machine-made peat so hygroscopic as the cut peat; it may be easily stored without absorbing water. When dried in the air it contains 15 to 25 per cent. of water.

Most of these machines knead the peat as it is taken from the bog. The machines thus used consist of a hollow cast-iron cylinder or cone, in which rotate one or two rollers set with knives or screw ridges, which break up the peat, mix it, and lastly press it through a mouth piece, which it leaves in the form of a continuous rectangular block. This block is wet and soft as the peat in its natural state, and is cut in pieces at proper lengths and then carried off to dry. Peat made in this manner is often called on the Continent, "compressed peat" (in German, *presstorf*), but it is evident that the pressure has been very slight; no water has been pressed from it, and its chemical composition has not changed; the only change is the increased density.

The first of these machines were constructed in 1861 by C. Schlickeysn in Berlin, and though since then modified in various respects, they are still on the whole much like the original model. The most modern and most improved are those from the Munktells factory at Eskilstuna in Sweden, constructed by the Swedish engineer Aleph Anrys. Several hundred of these machines are in use in Sweden and especially in Russia. On the large bogs of the latter country, often up to 20,000 acres in extent, 50 to 70 machines of this kind may be seen at work. Each machine is worked by a locomobile of 12 horse-power and employs 30 labourers, the daily output being 40 to 60 metric tons of peat in the dry state. The working costs are about 3 shillings 4 pence (80 cents) per metric ton of dried peat, the wages of the labourers being about one dollar (in Sweden).

In Germany most of the peat-pressing machines are made by R. Dolberg in Rostock and by A. Heinen in Oldenburg. All these machines are much alike in their construction. The peat is dug from the bog with the spade and filled into an elevator, which carries it into the milling machine. Much hand work and many labourers are thus required for these machines, but they are able to handle 1½ to 2 tons of peat per man per day.

Improvements may be made in these European peat factories, especially by replacing the individual locomobiles at each machine by a central power plant, and transmitting power to an electric motor for each peat presser. The digging and carrying away of the peat, which is everywhere performed by labourers, ought also to be done by electric power. Costs would then be much reduced where wages are high.



ANRYS' PEAT-MILLING MACHINE OPENED TO SHOW CONSTRUCTION.

Digging and cutting machines, both for hand and steam working, are used in eastern Germany and in the Netherlands, but only where the bogs are so wet and swampy that the water may not be drained away and cutting by hand in ordinary manner is consequently impossible. Most of these cutting machines are made by Dolberg in Rostock. They are used floating on prams or standing on rails on the bogs. The peat dug out is then immediately carried to the milling machines, but may also be used as ordinary cut peat. In the Netherlands one single manufacturer by this method makes in a summer nearly 100,000 metric tons of dried peat, all of which is sold in Amsterdam, the selling price being about 18 shillings ($4.30) per ton. The Dutch burn peat in place of coal in their stoves, hence the high prices.

In some places the peat is milled together with water, and the half-liquid mixture is then moulded in forms like bricks. This method is used in the Netherlands and to some extent in Sweden, but has been worked out more particularly in Denmark. In that country one of the best planned peat factories in Europe is to be seen at the little railway station Sparkjer in Jutland. The operations performed there are rather different from those in other places and will prove advantag-

ANRY'S PEAT-MILLING MACHINE AT WORK AT STAFSJO, SWEDEN.

eous everywhere they may be used. The milling machinery is not, as in other peat factories, placed on the bog itself, but on the flat and sandy land immediately at the shore; the peat is carried up to the mill by a locomotive. The mill is driven by a stationary 12-horse-power steam engine and is of very simple construction, consisting only of a rectangular box 13 metres in length, in which rotates a roller set with knives that will break up the peat and mix it with water. The roller makes about 60 revolutions per minute. In this manner the peat is got into a semi-liquid state; it is then carried on rails by horses to the drying plain, where it is moulded into forms. The drying plain is situated on the flat and sandy land surrounding the bog; the same drying plain is thus used three or four times during the summer season.

Sixty-five metric tons per day of dried peat are thus made by 20 labourers, giving an output of more than 3 tons for each man. The costs of production amount to less than two-and-sixpence (60 cents) per metric ton, the wages being about 5 shillings 6 pence ($1.33) a day. In the figures of costs of the peat given here and elsewhere, amortisations are not included; but as these are rather small, they will not tend to increase costs substantially. The whole installation at Sparkjer, with exception of the bog, cost about $9,000; as the peat is sold on the place at a price of 7 shillings ($1.75) per ton, it is seen that there will be a good margin of profit.

In the peat factory at Sparkjer, some floating peat mills are also used. The milling machinery, together with a 2-horse-power gasoline motor, is mounted on a pram floating in the turf pit. At these small plants four labourers will make 13 tons of dried peat per day. Costs are even smaller than the above, not exceeding 51 cents per metric ton. Throughout Europe machine-made peat is nowhere produced at so small cost. The inventor of the appliances at Sparkjer is the Danish captain of horse Rahbek.

For a long time much attention has been given to the coking of peat in order to get a substitute for wood charcoal and for coke, the charcoal of peat ranging between these two. Formerly peat-coke was used in several places in Germany and in Austria for metallurgical purposes, and many different methods and various kilns have been proposed and used for the coking, all of which have proved more or less unsuitable for the purpose, uneconomical, and upon the whole unsuccessful, the peat coke being too costly to compete with coke from coal. In Europe, therefore, there was for many years only one factory for peat-coking, but in the last two years one or two more have been established. A plant with five kilns, according to the method of Dr. Ziegler, of Berlin, was erected in 1894 in Oldenburg, in the midst of the most extensive peat areas of Germany. In each kiln 10 to 12 metric tons of peat are coked in 24 hours, 3 tons of peat giving on an average one ton of coke. The heat in the kilns reaches 600 degrees C. (about 1,100 F.) and the coking is complete. All volatile matter is driven out and the coke burns without flame. The gases are used for the heating of the kilns, and are sufficient for that purpose and for heating in addition the boiler of a steam plant. The coke is sold at a price of 60 marks (60 shillings or $14 to $15) per metric ton, but as it is almost completely free from sulphur it is highly useful for metallurgical purposes and thus competes with wood charcoal. It is also much used by braziers and the like. Besides coke and the heating gases, the

peat on coking will give tar and tar water, this being actually the case in Oldenburg, where gas, oil, sulphate of ammonium, etc., are sold as secondary products.

Dr. Ziegler has planned in Russia a coking plant for peat on the same principles as that in Oldenburg, but with the object of getting coke for locomotive use. The locomotives in Russia usually are fired with wood and mineral oils, as coal is scarce in that country, and the importation is very small. In order to be independent of foreign supply of fuel, the Russian government is trying to use peat coke for firing the locomotives, and has built a plant on the Ziegler system at Redkino on the railway between St. Petersburg and Moscow. In view of the purpose for which the coke is intended, the coking is not complete, but the fuel retains much of the bituminous matter and therefore burns with a long and bright flame, and is thus well fitted for the purpose. The yield of coke from the peat is thus increased, so that the weight obtained is half that of the peat. The success of this plant has proved good, and it is the intention to build several others in various places in Russia.

In Western Norway, near Bergen, a peat-coking plant has been built of late on somewhat different principles, the heating being effected by an electric current, taken from a waterfall in the neighbourhood. Each kiln is loaded with 400 to 500 kilograms of dried machine-made peat, and the coking takes some 3 to 4 hours. The electric current is of 500 amperes with a tension of 40 to 50 volts; the temperature in the kilns is about 300 degrees C. (570 degrees F.). The coke is rather compact and burns with a long and bright flame; it is very well suited for domestic purposes and sells in Bergen at a price of 15 shillings ($3.60) per metric ton.

In very recent years factories have been built in Europe for the briquetting* of dried peat; the briquettes are much like those of brown coal (lignite) in appearance and calorific power; they are very solid and have a fine and polished surface from the strong pressure. The peat is partly dried artificially in the factory, then crumbled, and lastly pressed in open press forms under a very heavy pressure—about 1,500 atmospheres. The press forms are open, as the friction is sufficient to produce the needed resistance. The specific gravity of the peat briquettes exceeds unity, and they have a calorific power about three-fourths that of ordinary coal. At present there are four such plants existing in Europe, viz., two in Germany, one in the Netherlands, and one in Russia, but it is to be supposed that more will be built, as the

* For briquetting machines, *vide* also the March, 1902, issue of this Magazine.

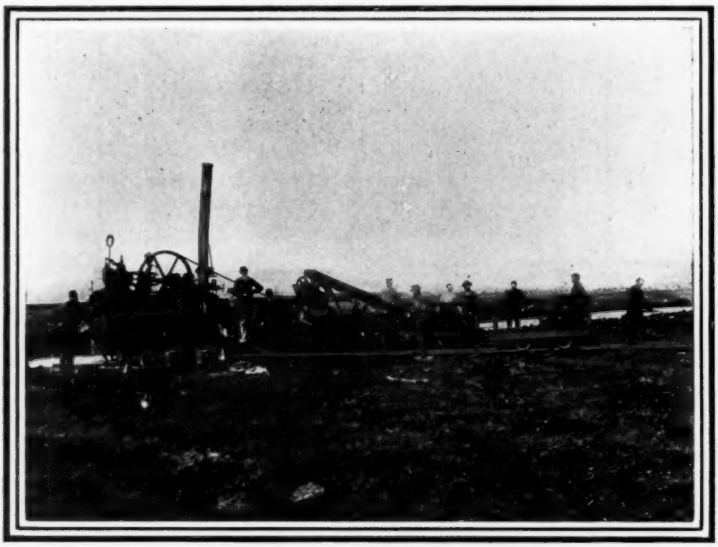
PEAT-MILLING MACHINE ON THE OLDENBURG MOORS, GERMANY.

briquettes of peat, as well as those of lignite, are very clean to handle and thus very well fitted for household use as fuel.

Germany and the Netherlands are the native countries of peat-fuel making. In both these lands peat has been used from very ancient times, as already stated, and it is in Germany that most of the modern methods for its manufacture have been worked out. In fact, especially in Germany, much labour and much money have been spent in various unsuccessful methods of manufacture. In these countries also, peat is today very commonly used, more especially in the Netherlands. Within recent times Sweden, Denmark, and Russia have widely enlarged their peat production. In Austria, also, peat is much used in factories, especially in glass houses and brick manufactories. In Norway peat is used in the stoves in the western part of the country, where wood is scarce; but though bogs are found almost everywhere, there are no large peat factories, owing to the scanty population of

this country, and to the fact that water power is obtainable in most places for industrial uses.

Apart from hand-cutting of peat, milling through machines as described is almost the only method used throughout Europe. But as the peat to fill into the machines is dug by hand, many labourers are required, and this circumstance will make peat costly where wages are high, and as these tend to increase everywhere, machinery must be constructed to dig the peat; but with the exception of very low-lying bogs where water stands on the very surface, such appliances are nowhere used as yet.



PEAT MILLING WITH HEINEN MACHINES ON THE OLDENBURG MOORS.

In northwestern Germany and in the Netherlands, peat is used chiefly as domestic fuel and, as stated above, is sold in Amsterdam at prices absolutely higher than those of coal, peat measured by its thermal effects being more than twice as costly as coal. There is no special construction of the stoves, but in Denmark a special patented device, the so-called "spit-stove" of Mr. Reck, is used for peat combustion.

In southern and eastern Germany, but above all in Russia and in Sweden, peat is used principally for industrial purposes, a great many boilers, small and large, being peat-fired. In breweries, distilleries, and

under salt-pans, peat is used in Germany on a very large scale and is very advantageous for these purposes, the heat being not so intense as when coal is used. Moreover, as peat contains no sulphur, the caldrons and boilers are not subject to so much injury as when coal-fired. It is estimated that they will last three times as long as when coal is used for fuel. Boilers of any size may be heated by peat; for the larger units step-grates are the most suitable; the peat may then be fired even when rather wet, this being of importance in summers when drying is difficult and not thoroughly performed.

Ordinary peat has a thermal effect about half that of coal, the accurate proportion being as 1:1.8. Hence it follows that the transportation of a thermal unit in peat will cost about twice as much as in coal. Establishments based upon the use of peat fuel should therefore generally be placed very near the bogs, this being actually the case in eastern Germany and in Russia. But as this is a very heavy drawback, bogs often lying apart and far from the great lines of transportation, central power plants should be erected in the middle of the large bog areas, and power transmitted electrically to places more suitable for the factories. Such power plants have not as yet been established, but it is easy to show that fuel for one horse power in such a plant, erected in the immediate vicinity of the bog will cost only 1/9 of a cent per hour.

In an article contributed by W. O. Webber to this Magazine for the issue of September, 1898, it is stated, that in the best large steam-power plants only one pound of coal is used for one horse-power hour. As one pound of ordinary coal is equal to 1.8 pounds of peat, this costing 5 shillings or $1.25 per ton, the cost of peat fuel will not exceed 1/9 of a cent per horse-power hour.

Gas from peat is used for heating purposes in several places in Europe, but most extensively in Sweden. In that country it is used for the melting of Martin steel, while in other places it is used in glass houses and the like. The generators used are of very simple construction. In a Swedish magazine, *Jernkontorets Annaler,* Rich Aakermann has given an exhaustive memoir on the use of gas for Martin-steel melting.

The peat used in Sweden for generating gas has the following composition:

Carbon	60.0 per cent.
Hydrogen	6.4 " "
Oxygen	31.7 " "
Nitrogen	1.9 " "

Or, if hygroscopic water and ashes be reckoned:

Carbon	38.2	per cent.
Hydrogen	4.1	" "
Oxygen	20.2	" "
Nitrogen	1.2	" "
Sulphur	0.0	" "
Ash	8.6	" "
Water (hygroscopic)	27.7	" "

The gases have the following composition:

CO_2	6.9	per cent. of volume.
CO	26.0	" " " "
C_2H_4	0.5	" " " "
CH_4	4.4	" " " "
H	8.5	" " " "
N	53.7	" " " "

The quantity of gas obtained from 100 kilograms of peat is about 252 cubic metres. The sorts of peat here used have an excessive amount of ash and much hygroscopic water. In fact, ordinary peat will not have more than 5 per cent. of ash and when well dried in the air, it will not contain more than 20 per cent. of water; under such conditions the gas will be of much better composition.

It is not known that peat is used anywhere in Europe to produce power gas on any particularly large scale, but the results obtained of late with the Mond gas generators, where power gas is generated from slack coal with 60 per cent. of carbon, would tend to show that peat will give as good results.

In reality, there is no great difference between such slack coal with 60 per cent. of carbon and good peat, the only difference being the greater contents of water in the peat. But as two and a-half tons of water, as steam, are used in the Mond gas generators to one ton of slack coal, to regulate the process, the larger amount of water in the peat must not be considered as a drawback, but rather as tending to make the generating of steam superfluous and thus to reduce costs.

In the figures given above, showing the composition of Swedish peat gases, nitrogen is present in rather large amount. This results from unmixed air being used for the combustion in the generators; when it is properly mixed with steam and carbonic oxide the results obtained will prove better.

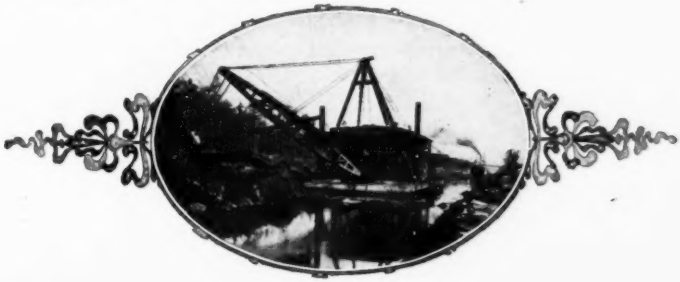
It is now well known that gas may be led economically to great distances, for power supply and for incandescent lamps. Thus Mond gas is piped in England from central gas works to the surrounding factories, and in Pennsylvania natural gas is piped for distances ex-

HEINEN'S WORKS FOR BUILDING PEAT-MILLING MACHINES AT VAREL, OLDENBURG, GERMANY.

ceeding 90 miles. There is no reason why gas from peat should not be used in the same manner.

It is my opinion that where the peat cannot be used in factories on the spot, it should not be transported, as costs will be nearly double those for carriage of coal; but power should be transmitted, either in the form of electricity or as peat gas—the former for long distances, the latter for shorter ones.

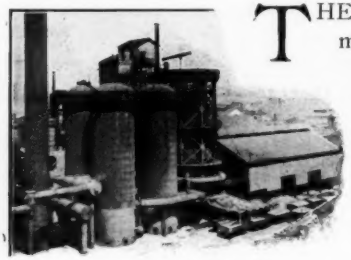
The use of peat on a larger scale than hitherto will not only prove to give cheap fuel, but the digging out of the bogs will in many cases make the countries more wholesome and the bottom of the bogs will give a fertile soil, as is seen in the Netherlands.



PROGRESS IN INTERNAL-COMBUSTION ENGINES.

By W. H. Booth.

Attention has frequently been drawn in these pages to the enormous possibilities of power economy yet to be realised by the utilisation of blast-furnace gases in the internal-combustion engine. This is the direction in which the gas engine is making its most striking progress; the largest units exhibited at Düsseldorf last summer, and illustrated in these pages in October, are but half the size of the machines already under construction in the United States. But this progress follows step-by-step the advance in mechanical excellence and thermodynamic efficiency which is Mr. Booth's chief topic.—The Editors.



THE progress of the gas engine, which may be termed the general representative of the whole genus of internal-combustion engines, has not been particularly rapid. Though the correct cycle of operations was indicated by Beau de Rochas in 1862, it required many years to put his clearly defined propositions into practice. Others had appreciated the necessity of compression before his time, but probably no one so clearly grasped the whole theory of the gas engine as he; for he went so far as to point out that there was a limit to the degree of compression in the spontaneous combustion that would occur at high compressions—a limit the significance of which, in reference to the future of gas engines and gas producers, has not yet been generally appreciated. Though Beau de Rochas expounded a correct theory in 1862, the best, or at least the most popular, gas engine up to about the year 1877 was the gun or free-piston engine of Otto and Langen, though in 1876 Otto had begun to build engines based on the Beau de Rochas cycle, which has since been incorrectly and unfairly called the Otto cycle. Scientific men, as a rule, have contented themselves as regards mechanical arts with fitting theories to machines laboriously elaborated by practical men groping in the dark. The practical man has had but little aid from the theorist until too late. Beau de Rochas was a decided exception to the rule, for he fully grasped the theory of the gas engine and laid down rules to which the practical man has only today signified his adherence. It required fifteen years

before the Rochas cycle was taken up by Otto, and it has required forty years before the next step has become at all popular, though Beau de Rochas came perilously near to inventing the Diesel engine also.

The first practical engines, the Lenoir and the Otto and Langen, the Bischoff, and a host of others, simply drew in a charge of mixed air and gas and exploded it in the cylinder. As soon as the Otto engine with the Beau de Rochas cycle had come fairly on the market, all the previous engines disappeared. The Rochas cycle held the field and was variously modified. Atkinson, for example, brought out an engine in which the explosive charge was drawn in and compressed by a piston travel less than the travel on the explosion stroke. He thus obtained a better expansion of the exploded charge, while the longer exhaust stroke effectively scavenged the cylinder of burnt gases.

The Griffin engine had two idle revolutions, in place of one, to each explosive stroke, the extra revolution serving to give a scavenging stroke to drive out the last of the burned gases which diminish the value of the next explosion. Other inventors have aimed to secure an explosion every revolution, though still adhering to the Rochas cycle. Thus Clerk employed a separate charge-compressing pump, and Benz and others have followed on similar lines. In the Smith engine, for example, there is a free inner piston, kept apart from the main piston by a long coiled spring. This free piston is in close contact with the main piston during the explosive stroke. When the exhaust opens at the back of the cylinder, the main piston uncovers the air and gas or petrol port near the front of the cylinder. Relieved from pressure, the free piston is driven rapidly back by the spring, expelling the burned charge and drawing in the new charge which fills the space between the two pistons. The main piston now returns and forces the charge through a backward-opening valve in the free piston into the compression space, and the two pistons meet flatly face to face without any remaining charge between them. The valve in the free piston closes with a light spring and the compressed charge is exploded behind the free piston, which is now in solid contact with the main piston. The two pistons move forward as one and the cycle is repeated, an explosion being secured every revolution. The Smith engine has only been made so far in small sizes.

Many engines have been made with the exhaust port forward, the new charge being forced in at the back of the cylinder to be compressed on the return stroke in order to secure an explosive stroke each revolution. Where blast-furnace gas has been employed, air has

conveniently been used from the blowing engines to give a scavenging to the cylinder, but all varieties are but variants of the Rochas cycle.

It has become daily more apparent that high rates of compression must accompany economy. Here, however, a difficulty has presented itself, more especially in petrol engines, the vapour of which is so rich in hydrogen or its carbon compounds. Hydrogenous gases are much more easily ignited than carbonic oxide, and until recently it has been widely held necessary or desirable that even producer gas should contain a percentage of hydrogen, in order that ignition should be the more easily and certainly effected. Hence the use of steam in gas producers. The steam becomes decomposed in passing through the incandescent carbon and the hydrogen appears in the gas and no doubt does facilitate ignition. All gases, however, when compressed become heated, and the point is soon reached where a combustible gas compressed in the presence of air becomes hot enough to combine with the oxygen of the air. Hence arose premature ignitions. Indeed, the trouble with illuminating gas has been so serious that many installations of electric power with gas as motive power have been condemned as failures. The presence of hydrogen has proved a bar to high compression, and the result has been that there are two camps of producer-gas men—those who, like Mr. Thwaite, demand a gas almost wholly of carbonic oxide as regards the combustible constituents, and those who advocate a proportion of hydrogen. With the present form of gas engine the former appear to be on the winning side, because they can use much higher compression without danger of early explosion and its accompanying risks. While gas engines were small these risks were of comparatively small moment, but with large engines they become much more serious, producing heavy shocks and dangerous reversals.*

Had it not been for producer gas, the progress of the gas engine in large sizes would have been small. Having grown large and fairly perfect, it is evident that petroleum affords an excellent fuel for the internal-combustion engine, but it is so readily ignited, being so highly hydrogenous, that only moderate rates of compression can be employed with safety. Finality has been attained in the principle of compression of the explosive mixture.

* In the engine designed by Donàt Banki, and built by Ganz & Co., of Budapest, a spray of water is atomised and drawn in with the gas, this raising the igniting point of the charge to an extent permitting a high degree of compression without danger of pre-ignition. The expansion of the vapour of water returns as power the heat which it absorbs, and a high degree of economy is obtained. These engines operate well only with benzine, gasoline, and similar light fuels.

At this point a fresh inventor appears in Herr Diesel, who has advanced the gas engine to the point that appears to have been foreseen by Beau de Rochas. Recognising that there is an early limit to possible compression, but that there is economy in possible higher compression, this inventor has refused to compress the explosive mixture. He compresses air alone. By doing this apart from any combustible, he is already employing compression to 35 atmospheres or say 500 pounds per square inch. The high rate of compression renders the air exceedingly hot, so hot indeed that it will ignite any combustible brought into contact with it. Into this hot air, petroleum is injected by a small pump and it is at once ignited and by its combustion it enables the compressed gas to expand along a curve of pressure greater at any point than the pressure during compression. Hitherto liquid fuel has been employed in this engine, but there is no reason why gas should not be used. This system opens up at once a new field in gas producers. It renders possible the employment of any hydrogenous gas, for there can be no premature ignition, no fuel being admitted to the cylinder until the proper time, and then not exploding but simply burning quietly as an ordinary flame jet. There is now no limit to the intensity of compression that can be given, excepting the mechanical difficulties, which appear to be perfectly surmounted up to the abovenamed pressure of 35 atmospheres. There is also the question of temperature to be considered. In this respect the ordinary gas engine explodes the whole of its charge at or near the dead point, and the exploded charge is at a very high initial temperature and much heat is lost to the walls of the cylinder and to the jacket water. In the newer method the initial temperature is less. The fuel is admitted through a certain period of time, and as fast as it generates heat so fast does this heat disappear in the form of work done on the now moving piston, and also still to the jacket. But the temperature being always kept more moderate, the "head," or difference of temperature between the gases and the jacket, is less than in the explosion engine and the heat losses to the jacket are less also. Scientifically, the water jacket of the gas engine is an absurdity, only to be tolerated because we have not learned to control the temperature in the cylinder or to make a cylinder capable of working at the high temperature generated within it. We therefore surround the cylinder with a protective shell of water, knowing all the time that the principle of this is bad. The Diesel engine still requires its water jacket, but less heat is now lost to it. It is thus a step forward towards that thermodynamic perfection, the fundamentals of which were so clearly defined by Beau

de Rochas forty years ago, but have been so tardily and laboriously acted upon by practical men.

Mr. Emerson Dowson, who was among the first to apply the cheap or producer gases to the driving of gas engines, has stated that a power gas should not contain less than 1,200 calories per cubic metre (135 B. T. U. per cubic foot) and that it should contain 15 per cent. of hydrogen to ensure its certain and easy ignition at the rapid frequence necessary in gas engines. The following is a characteristic analysis of a gas made in a Dowson producer.

Hydrogen	20 per cent.	Proportion of air necessary for combustion, 107.5.
Carbonic oxide	20 "	
Carbon dioxide	7 "	
Nitrogen	50 "	

Calorific value, 138.4 B. T. U.
Ratio of calorific value of CO. to total, 53 per cent.

Herr Ludwig Mond produces a gas which analyses as follows:

Hydrogen	29 per cent.	Proportion of air necessary for combustion, 120.
Carbonic oxide	11 "	
Marsh gas	2 "	
Carbon dioxide	16 "	
Nitrogen	42 "	

Calorific value, 135.3 B. T. U.
Ratio of calorific value of CO. to total, 26 per cent.

In 1894 Mr. B. H. Thwaite synthesised a gas with the proportions of blast-furnace gas, and found that it worked well in gas engines and quite exploded the general opinion, theretofore held, that so poor gas was too poor to burn satisfactorily in a gas engine. The heating effect of compression and the closer approximation of the gas molecules had not before been recognised as possessing the important effects they are now discovered to possess in undesirable excess.

Mr. Thwaite expressed the opinion that hydrogen was not a desirable constituent of power gas, because in its combustion so much heat is rendered latent in the steam formed by its combustion and cannot be recovered except by recondensation to water. He stated, secondly, that a gas should be fixed and not liable to condense to a liquid form under the influence either of low temperature or of compression; also that no constituent of a power gas is desirable when a small addition or subtraction of that constituent makes a considerable difference in the calorific capacity per cubic foot. Hydrogen is particularly undesirable in the poor gases, because these require considerable compression to secure economical results and premature explosions are thus induced. If compression is kept low as a safeguard against possible variation of

hydrogen and premature ignition, there is introduced the disadvantage of delayed ignition whenever the more readily ignited constituent shall happen to be present in less than normal quantity. Hence any variation of hydrogen involves danger of pre-ignition, or risk of loss should low compression be employed to avoid the danger. When hydrogen and hydrocarbons are kept within the limits laid down, the expansion curves of the indicator diagrams are remarkably steady and even and successive diagrams coincide in every line. The limit of hydrogen laid down is 3 per cent. I am indebted to Mr. Thwaite for the following analysis of his ideal gas.

Carbonic oxide	30 per cent.	Proportion of air necessary for combustion, 77½.
Hydrogen	1 "	
Carbon dioxide	10 "	
Nitrogen	59 "	

Calorific capacity, 99.4 B. T. U.

Ratio of calorific capacity of CO. to total, 96 per cent.

This gas certainly does not fill the requirements laid down by Mr. Dowson, for it has barely 100 B. T. U. of calorific capacity per cubic foot. Yet in tests of gas engines carried out by me with gas of this value, perfect results have been secured both in prompt ignition and in uniform steady expansion curves, showing that success is a matter largely of properly regulated compression, which is a difficult matter to secure where small producers are used to give hydrogenised gas, for the hydrogen is so apt to vary in amount that the compression cannot be satisfactorily adjusted. Others have also expressed their dissatisfaction with gas so low in heat value as 100 B. T. U., and it is to be feared that to these objections much of the opposition to the employment of that huge waste of blast-furnace gas has been due in Great Britain. On the continent especially this hitherto nearly wasted product has been largely utilised, and as the first immediate result gas engines of very large powers are plentiful and the gas-engine industry has received an impetus that it has wanted in Great Britain. When the value of blast-furnace gas has been finally recognised, the British builders of large gas engines will be unable to supply the demand and for some time large gas engines will be imported. The Düsseldorf Exhibition shows the position of the continental gas-engine industry very clearly.

The efficiency of combustion is a function of the degree of compression prior to ignition of the charge. In early experiments with gas as poor as 80 to 100 B. T. U. per cubic foot it was found necessary at once to raise the compression from an absolute of 4 atmospheres to 7 or 8 atmospheres, a rate that would be more or less risky with

hydrogen in too great a proportion. Experience has shown that the degree of compression should be inversely as the calorific power of the gas used.

While on the Continent tens of thousands of horse power are being installed from blast-furnace gas containing little or no hydrogen, what do we find in England, where gases of over 15 per cent. of hydrogen have been attempted at various electric stations? The gas power has been replaced by steam power. Leyton, Kings Lynn, Morecambe, Belfast,—what has been the fate of the hydrogenous gas-power installations at these places? Where have they failed to give satisfaction? It is found that non-hydrogenised gases are steadily extending their field of operation, and that the hydrogenised gases are associated with failure except perhaps in the smaller powers, may it not be fairly ascribed to the effects and causes pointed out in the foregoing?

It is none the less remarkable that just when the doom of the hydrogenised gases appears to be imminent, the gas engine in which a too facile ignition is impossible should make its successful début. Hydrogen as a constituent of power gas will lose all its disadvantages, unless it be that of loss due to heat latency. Every gas used in the Diesel engine will be used to the full extent of its possibilities at present in our knowledge, and in the Diesel engine there is present a motor with a certainty of action and a steadiness of impulse and movement that will go far towards putting gas engines on a par with the steam engine in certainty of action and quietness, while far ahead of the steam engine in thermodynamic efficiency.

In experimenting with the petrol engines I have constantly been hampered by the difficulty of compressing to a desirable degree and have found it necessary to keep this feature moderate, as well as to guard against projections from the plain surface of the internal parts of the cylinder, such parts becoming hot and causing ignition, often before full compression has been attained. Petrol has no difficulties for the Diesel engine. The progress of the gas engine and the means of producing gas is indeed somewhat on a par with that of the gun and the armour against which it is pitted. Each has in turn taken a step in advance of the other.

THE ECONOMICAL SIGNIFICANCE OF A HIGH WAGE RATE.

By Percy Longmuir.

The ultimate expensiveness of low-priced labour has been argued often and from many points of view. Mr. W. E. Partridge, writing in this Magazine ten years ago (August, 1892), brought together a number of striking examples, chiefly from American practice, exemplifying the fact. Mr. Longmuir, studying wholly British conditions, makes a very clear analysis of the reasons. It is the more impressive because so deliberately unimpassioned. The cold logic of a mechanical demonstration may be more effective in industrial reform than any sympathetic appeal of the humanitarian. In our Editorial Comment this month we have more to say of the fallacy which leads to "sweating"—the fallacy that it is the time, instead of the product or output, of the worker that is bought by the employer.—The Editors.

LEST the heading of this article be misunderstood, I would clearly state at its commencement that my text is not "the higher the wages the greater the economy," for it is very obvious that an increase of wage without a proportionate increase in either the quantity or the quality of the product will not tend to economy.

In all industrial operations subject to competitive stress, effort is concentrated to one issue—that is, towards an increase of quality together with a decrease in the unit cost of the article produced. To achieve this end, mechanical means are the first essential; but it is very well recognised that the successful developement of mechanical appliances depends on the amount of effort put forth by the human faculty controlling the mechanical share of the work. In the evolution of industry, advances made in mechanical appliances and processes must be coincident with similar advances on the part of the human working force. Should conditions be otherwise, and the personnel of the working forces not advance correspondingly with newer methods and newer tools, then naturally the benefits of the latter will be minimised to the extent indicated by the lack of developement in the former.

It is very permissible to regard what have just been termed the "human working forces" as energy-producing machines, and in so doing the work produced may represent a definite mechanical product. The nature of this product of the human machine will depend on two things—first his willingness, and second, his physical fitness. In this work-a-day world, dominated as it is by what, for want of a better term, must be defined as "human nature," there are numbers physi-

cally fit, but who, owing to mental obtuseness, narrowing environment, or laziness unadulterated, are mentally very unwilling to produce an amount of work equivalent to their physical condition. But there are also numbers mentally willing, yet physically very unfit to produce a normal amount of work or energy. Both these classes have a very considerable effect on the cost and character of the work they produce, and the elimination of either evil would mark a very distinct advance in industrial evolution. The former—that of mental unwillingness—is purely an educational question; the latter—that of physical fitness—is perhaps one of larger moment, and certainly a very pressing question in Britain today. We are confronted with a constantly growing army of physical non-efficients, and if the profession of engineering is to be the dominating one of the future, as has been already indicated in the pages of this Magazine, then this question of physical deterioration is primarily one of engineering importance, and one of special moment to those engineers in charge of large bodies of men. In previous articles* some of the root causes underlying this deterioration have been noted, and in the present one an effort has been made to trace the relationship between the rate of wages paid and its effect on the character or quality of the work produced—in other words, to examine broadly the matter of a high wage rate and whether or no such a rate is conducive to economical production. The term "high wage rate" is one which does not admit a ready definition; in the case of skilled labour it is usually regarded as anything higher than the rate prevailing in the district, but with unskilled labour it is extremely difficult to determine rates that may be fairly regarded as low or high. This difficulty is increased by the varying character of the work classed as unskilled, and in order not to err on the sympathetic side, nor yet on the other hand to take an unjust view, it seemed well to class as a high wage rate for unskilled workers a sum just sufficient to maintain the worker and his family in a state of bare physical efficiency. Such a sum will of necessity vary according to the size of the workers family, and in some degree with the locality; but no better average can be found than that adopted by Mr. B. S. Rowntree of York in his exhaustive work on "Poverty." In fixing a poverty line, that is, a sum at which the worker might be regarded as just beyond the range of actual poverty, Mr. Rowntree went very thoroughly into the matter of economical food and the amount necessary to maintain bare physical efficiency. Without giving details of this very untempting scale of diet, I may quote the figures necessary to my purpose. Assuming

* THE ENGINEERING MAGAZINE, January, March, and April, 1902.

the family to consist of five persons, that is, the parents and three children (which by the way is a low average of the families of unskilled workers in Great Britain), then the weekly items are tabulated as follows:

	s.	d.
Food for two adults, 3s. each per week	6	0
Food for three children, 2s. 3d	6	9
Rent per week	4	0
Clothes for two adults, 6d	1	0
Clothes for three children, 5d	1	3
All else, five persons, 2d		10
Fuel and kindred charges	1	10
	£1	1 8

By no possible stretch of imagination can the foregoing table be called an extravagant one, and in view of its essential fairness it forms a very appropriate standard for our purpose. It must, however, be remembered that this figure covers only the bare maintenance of bodily efficiency. It allows nothing for sickness, nothing for luxuries, not even a postage stamp or an evening paper. Therefore families in receipt of an income less than 21s. 8d. per week are in a condition of absolute poverty, and the wage earner cannot possibly be in a state of physical efficiency. The only wage earners coming below this poverty line are the ones known as unskilled labourers, and in considering the effect of a wage rate it will be necessary to separate this class from the one generally known as skilled workers. Obviously in considering the economy of the question the two cases must be viewed from very different standpoints, and it will be better to devote the first section to that of unskilled workers.

Unskilled Workers.—General labourers, who form the greater portion of this class, are in one sense non-producers, and are often regarded as costly no matter what relationship their rate of pay and the character of the work they perform bear to each other. In this paper only adult labourers are considered, and for convenience these may be divided into classes representing districts of Britain in which the rates vary as follows:

1. 16s. to 18s. per week.
2. 18s. to 20s. " "
3. 20s. to 22s. " "
4. 22s. to 24s. " "

The week in all cases consists of fifty-four hours. Classes 3 and 4 may be regarded as high rates for the character of the work done, whilst classes 1 and 2 are distinctly low rates.

Areas in which the rates 1 and 2 are operative cover a considerable portion of Great Britain, and a preliminary glance at the recipients of these rates gives an impression that they are worth no more. As a rule they are saturated with specimens any recruiting sergeant or railroad ganger would regard as hopeless. Truly, the average appears to be one poorly equipped for the work termed unskilled, in which strength of body is all important.

Areas in which the rates 3 and 4 are operative contain the pick of the physique of the labouring classes. Among the ranks of these workers the hardiest and most wiry are to be found, and consequently the averages of these classes appear on very casual glance to be worth 24s. in far greater measure than is the average of class 1 and 2 worth 16s. per week.

This method of classing into districts governed by a uniform rate may possibly be questioned, but close observation over very wide areas points conclusively to the fact that the *élite* of the unskilled workers gravitate to those districts in which wages are higher. In spite of overcrowding and the restricting influences of town life, there is a constant influx of country labour into all our large towns; they respond to the magnet of a high wage rate quite irrespective of a possibly enhanced cost of living or other drawback. Naturally, then, the various grades of labour find themselves distributed in areas very representative of their physical fitness. Thus we have a seeming paradox, in that the country districts, whilst supplying the strongest and healthiest workers to the towns, are in themselves tenanted by workers of a lower physique. Once the youth of the country town or village feels able to command the, to him, high wages of a thickly populated centre, he quits his weekly income of 10 or 12s. and migrates to a possibility of 18s. or 24s. Should his condition fit him for the work, he will in all probability stay for life; but if otherwise, the inexorable process of sifting will drift him downward until he finds a level fitted for his capacity. A very striking example of this migration of country physique is to be found in the immediate district in which these words are penned. The extremely heavy and arduous labour classed as unskilled or partly skilled in the large steel works of the district, and that of the railroads, too, is for the most part performed by natives of the neighbouring agricultural county of Lincoln. This is the case with all large towns; they draw their supply of strength from the country districts, the natives of which, reared in the free air of pasture land or moorland, can readily compete with the average of stunted town growth when a question of bodily efficiency only is considered.

Examination of the prevalent rates for unskilled labour indicates that by far the greater part of the labourers in Great Britain are well below Rowntree's poverty line—that is to say, unless the wives work the total family income is below 21s. 8d. per week, and in many cases very much below. If the income is below the poverty line, no possible fancy of economical housekeeping will maintain that family in a condition of physical efficiency. With an unskilled labourer the first essential to constant employment is that of bodily efficiency, and from a financial point of view it is folly to employ a man in such a capacity who is otherwise than physically fit. For it is obvious that a man so handicapped cannot possibly do full justice to the work in hand, no matter how desirous he may be of doing so. His income will not allow him to supply his body with the necessary energy or fuel to yield the requisite amount of work. Just as no amount of forcing will make a machine yield more than the energy it represents, so no amount of hustling will get out of a man more energy than that represented by the scale of his diet. Successful hustling may obtain more show of energy, but it can not make the human machine yield more actual energy than that represented by its fuel or food. It may be argued that the quality of an unskilled labourer's food is hardly a question of moment to the busy engineer or works manager, but from our present point of view, that of an energy producer, it is all-important; and it is to this food, just as to the fuel that feeds his boilers, that the engineer must look for the energy which is to carry through his work efficiently and cheaply.

A practical illustration occurs at this moment. In gathering matter for the purpose of this paper, I studied for some time a very representative class of labourers in an area in which the standard rate was 16s. per week. Many of these men carried dinners to work, and the appearance of these parcels when opened at dinner time gave no little insight into the reason for lack of "go," and the almost complete absence of staying power, by which these men were characterised. As is usual with this class, the quantity and quality of the food fell as the week progressed, and towards the end the dinners usually consisted of bread and cheese or of bread smeared with lard or margarine, and occasionally dry bread only washed down with tea. One set of four men were in the habit of clubbing together and purchasing a luxury when their parcels happened to contain, as was not infrequent, bread only. They would subscribe a halfpenny each for the purpose of this luxury, which often as not consisted of a twopenny bottle of doubtful "pickles." Should this seem exaggerated to any reader, I would ask

him to divide carefully a weekly income—when full weeks are worked—of sixteen shillings, and make it cover all charges for a family—rent, food, fuel, clothing and contingencies such as sickness, absence or scarcity of employment, etc. Such an arithmetical exercise will doubtless demonstrate the fact that not all Britons fare on the time-honoured roast beef and plum duff.

That men on the diet just indicated are unfit for heavy and active work is readily apparent, and as a natural result in all districts having a low wage rate the works are found to be considerably overstaffed with unskilled labourers. It is no uncommon occurrence to find two men handling with difficulty a load that in a higher rated area, with consequently better calibre of men, would be readily tackled by one. That is to say, twenty-four shillings will do in a better manner work that in the low-rated and "cheap-labour" districts is costing thirty-two shillings. It is right here that the false economy of a wage rate upon which it is impossible to maintain any semblance of physical efficiency shows most distinctly.

The recipients of such a rate are necessarily stunted bodily; endurance and continued application are impossible; and with these evils are always associated mental torpidity or stagnation. Thus it is always found that to the incapacity to enter heartily and continuously into manual work is added mental blindness which very effectually prevents the adoption of system and "short cuts" in the accomplishment of that work. Briefly, then, in the low-wage areas the class of unskilled labour may be summarised as lacking in physical efficiency, possessing little or no endurance and no staying power, having no application. In short, they are apathetic, bodily and mentally, and it is evident that no matter how low the rate of pay or how intense the method of "drive," such a class of labour can never be satisfactory.

It has been already stated that the higher-rated districts contain the pick of the physique of the labouring classes, and this is more noticeable as the rate approaches four and twenty shillings per week. The men are better physically, and with this increase of physical efficiency is to be found a corresponding increase in mental capacity which results in the intuitive adoption of shorter and more direct methods in the accomplishment of work.

The Economy of the Question.—In this paper the only trace of sympathy admitted is that now familiarly known as "sympathetic works management," in which form of management sympathy is recognised as a paying factor. Therefore in looking at the matter of low-rated unskilled labour, the foremost question is, will the adoption

of higher rates be attended with a corresponding increase in the cost of production, or will the cost remain stationary? That is to say, will each shilling rise give an extra shilling's worth of work, or, assuming the wages to be increased from sixteen to twenty-four shillings, will the man so raised be enabled to give half as much work again, or will his product remain the same? In the cases familiar to the writer these questions, when put to a practical test, have been answered very strongly in the affirmative. Experience undoubtedly proves that an increase of wages results, with judicious management, in a corresponding increase of output. If this increase in output is proportional only to the amount of increase in wage, that is, if only one shilling's worth of extra work follows a shilling extra on the pay, then such an increase is economically justifiable. For increased output per unit results in a lessening of staff, which is followed by a lessening of management worries, clerical expenses, and a considerable diminution in risks such as come under the Compensation Act. But experience shows that the increase in wage results in a greater increase in the amount of extra work produced. Speaking generally, an unskilled labourer rated at twenty-four shillings will produce twice the amount of work to be obtained from one rated at sixteen shillings. Not only does he do twice the amount of work, but he also does it in a better and more workmanlike fashion. Thus an increase of eight shillings effects a direct saving of eight shillings, in addition to the indirect economy effected by a better product, more careful use of tools, and lessened management expenses. The economical significance of the wages rate is further shown in the following rough outline of the leading features familiar to low- and high-rated areas.

Low-rated areas.	1. Slow, unthinking, require direction at almost every step. 2. Clumsy; tools do not receive justice, either in method of handling or making them yield the most. 3. Low perception, no foresight, which tells heavily when working in conjunction with skilled labour. 4. High waste due to the non-recognition of the value of time, material, or tools.
High-rated areas.	1. Smarter, more methodical, require less personal direction. 2. Careful and more intelligent use of tools. 3. Higher perception, intuitiveness, requirements anticipated and skilled workers' time economised. 4. Less waste, due to better use of time, material, and tools. 5. Less strain on the management.

The higher rates permit an increase of physical efficiency which in turn results in an advance of mental capacity. The developement of per-

ception has an important effect on the work to be done, even though it be termed unskilled, as may be seen to good advantage when employed in association with skilled labour. In this case the efficiency of the labourer consists in anticipating the craftsman's requirements and in having everything ready to his hand, so that the work may progress smoothly and without interruption. In cases where perceptions are low, much of the craftsman's time is wasted in drilling and waiting for the labourer. The practical application of this increase in mental capacity is found in the better quality of the work done; instructions are more efficiently followed, tools intelligently used and cared for, and wits are set to work in conjunction with the body—that is to say, the apathy and dulness which often approaches senility, found with the semi-starvation of the low-rated areas, are replaced in the high-rated ones by systematic, methodical, and intelligent work.

Of the departments connected with an engineering establishment that of the foundry usually employs the largest proportion of unskilled labour. The labour is employed chiefly in association with the skilled labour in handling the heavy material, moulding boxes, and plates, and in preparing sand, etc. Owing to the absolute dependence of the skilled labour on the unskilled worker, and also the variety of work classed as unskilled, the foundry offers a good field in which to test practically the economy of a high rate. A comparison of two foundries in which the rates average respectively twenty-four and sixteen shillings per week, and in which conditions of management, character of product, etc., are very similar, conclusively testifies to the economy of the higher rate. The range of selection offered by this rate is such as to ensure the employment of picked men. The chief item of comparison—that of unskilled-labour cost per ton of good castings produced—is distinctly in favour of the higher rate. Not only is this the case, but subsidiary items, such as the repair and renewal of moulding boxes, which of necessity have to be handled by labourers, amount with the increased care and thought derived from the higher quality of the labour to considerably less per annum than is the case with the so called cheap labour. The thought put into the work is very effectual, as evidenced by economy of material such as facing sands, facings, core irons, lifters, sprigs, and the like. The smaller number and greater reliability of the men gives rise to a further factor of economy, in the relief afforded to the skilled worker and to the management.

A REVIEW OF WIRELESS-TELEGRAPH ENGINEERING PRACTICE.

By A. Frederick Collins.

Wireless telegraphy has advanced with wonderful swiftness from the position of a scientific curiosity to that of a branch of applied electricity. It is apparently destined not to supplant pre-existing agencies, except to a very limited extent; but rather to perform new functions for which preceding means of electric communication were not adapted.

Mr. Collins makes the first complete survey of the field, showing what are the fundamental elements common to all systems, and what the special features of method or apparatus peculiar to each.—THE EDITORS.

RECENT developments in wireless telegraphy, theoretical and practical, have placed this latest and greatest triumph of modern science in the domain of electrical-engineering practice, for it is now possible to design apparatus for the transmission and reception of electric waves to a distance of 100 miles with as much certainty of result and accuracy of action as it is a 1,000-kilowatt alternator.

At the present time there are several companies engaged in the manufacture, sale, and installation of instruments in the United States, in England, and on the Continent, and among the better known systems are those of Signor Guglielmo Marconi of England, Prof. Ferdinand Braun and Dr. Adolph Slaby of Germany, Mons. Emile Guarini Foresio of Belgium, Mons. E. Ducretet of France, Señor Julio Cervera Baviera of Spain, and Prof. Reginald Fessenden and Dr. Lee de Forest of the United States.

Whilst all these systems of wireless telegraphy are based on the same fundamental principles, there is a vast difference in their electrical and mechanical construction, as will be observed by comparison; this difference is due in some cases to the applicability of divers devices which perform virtually the same functions, but in the greater number of instances, this variation is the result of widely divergent opinions resulting from theoretical considerations; and again, individual inventive ability figures largely in the apparatus personified by the names above.

The greatest interest in wireless telegraphy at the present time, lies in the question of similarity of the component parts of the apparatus as a whole, for mighty legal battles will be waged in the near future with all the dynamic virulence which characterized the wars of the

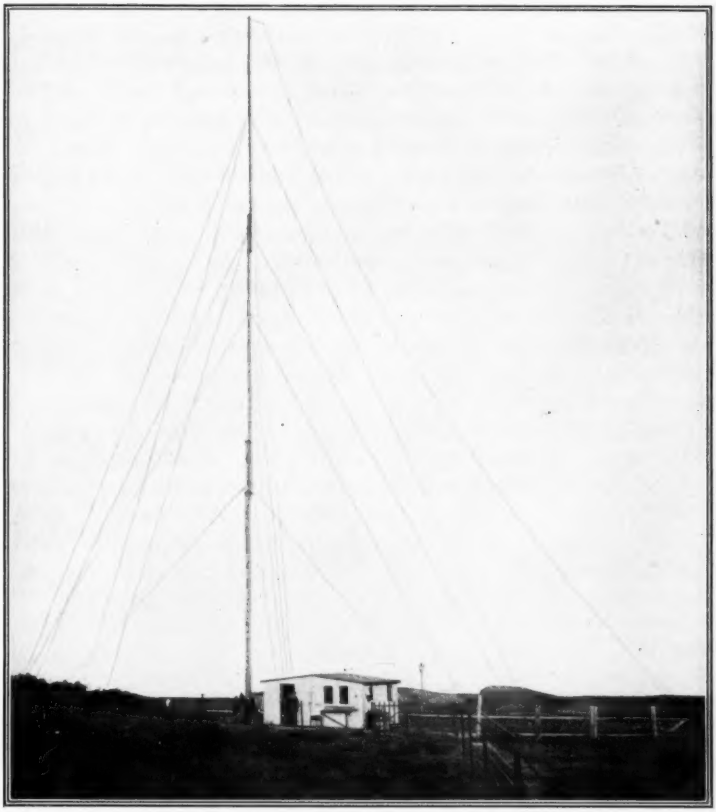
telephone companies, since priority of discovery and invention of the various workers and the commercial monopoly the patent rights grant to the different companies will be sustained by each, if possible.

Taking into consideration these three factors, *i. e.*, the scientific, the commercial and the legal phases of the art, the following text will be divided into three portions, the first of which will treat briefly the historical, the second dealing with the theoretical, and the last with the practical aspect of wireless telegraphy.

Historical:—The history of signalling through space without wires may be said to date back to the time of Lindsay—when he transmitted and received messages across the river Dee in Scotland by what is now known as the conductivity method; from that year until 1896 a number of schemes were formulated and some of them were put into experimental execution, including the induction method of Preece and the electrostatic methods of Edison and Dolbear; but until Marconi introduced the electromagnetic wave system, wireless telegraphy belonged to the practicable as distinguished from the practical period of its evolution; hence all systems other than those employing Hertzian waves will be excluded from this treatise.

A transmitter for the production and propagation of electric waves includes a source of current, means for interrupting a direct current (or an alternating current may be used), means for changing the interrupted or alternating current into low-frequency, high-potential currents, and means for transforming these into high-frequency, high-potential oscillations—such as are produced by the disruptive discharge of a Leyden jar through a circuit having a small resistance—and means for converting the oscillations into electric waves and emitting them; the receiver must provide means for intercepting the electric waves, and re-transforming them into electric oscillations, means for detecting minute differences of potential created by the enfeebled oscillations thus set up, and means for manifesting, either visually or audibly, these oscillatory hieroglyphics and translating them into readable Morse; besides other appliances having various special functions.

Without delving into the records of direct, alternating, and induced currents, the history of which is well-known, a mere retrospective glance at oscillatory currents—which play so important a *rôle* in wireless telegraphy—will suffice to illustrate the real beginning of the knowledge upon which the art is founded. Felix Savary, in 1827, postulated with marvelous accuracy the now accepted theory of the oscillatory nature of a disruptive discharge, showing that the charges of the inner and outer coatings of a condenser were not restored to



EXTERIOR OF WIRELESS-TELEGRAPH STATION AT CUXHAVEN, GERMANY.
BRAUN SYSTEM.

zero potential by the mere single passage of current electricity in one direction, but that the equalization was due to several reflex actions—like the vibrations of a steel spring—before the electrical equilibrium was obtained. Joseph Henry in 1842 obtained experimental proof of this phenomenon by observing the changes of polarity in fine steel needles when magnetized by a frictional (plate-glass) electric machine at a distance. In 1847, Von Helmholtz published in his "Conservation of Energy" his deductions relating to oscillatory currents, proving mathematically that the discharge of a Leyden jar is a "backward and forward motion until the entire *vis viva* is destroyed by the sum of

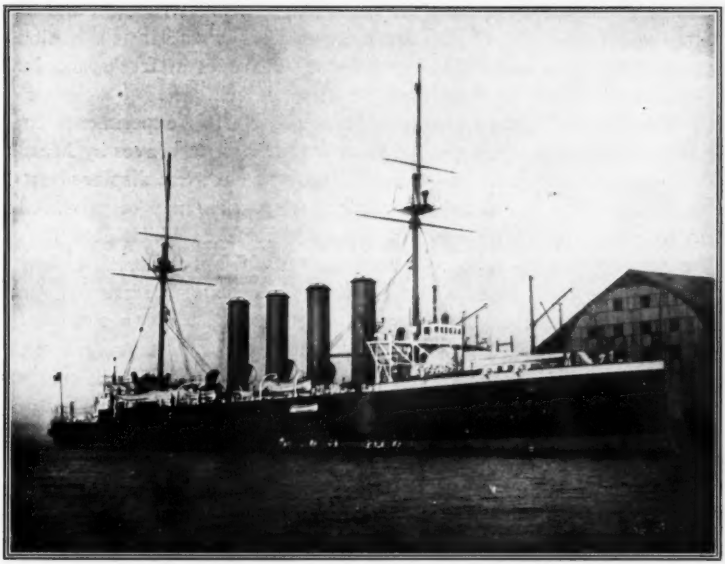
the resistances." In 1852 these deductions were verified by Sir William Thomson, now Lord Kelvin, who worked out the theory on the experimental evidence of Faraday, who had obtained oxygen and hydrogen mixed at either pole. Lord Kelvin suggested a method by which the spark of a discharge could be segregated, by means of a Wheatstone revolving mirror, and in 1859 Fedderson adopted this means and succeeded in detecting a series of minute sparks and placing the work of those before him on a sound physical plane.

Through another of Faraday's classical experiments, James Clerk-Maxwell was led, in 1865, to evolve his electromagnetic theory of light which, simply stated, resolves all forms of transverse vibrations of the ether, or polarizations, into waves composed of magnetic whirls and electric displacements alternately; he determined mathematically that these polarizations were due to rapidly moving charges of electricity shearing the ether—as when an oscillatory current of a discharged Leyden jar traverses its circuit; likewise it was ascertained that the periodicity of oscillation depended on the size of the body in which the current surged; on a body of atomic size it would oscillate trillions of times per second, emitting visible waves, but on a sphere of say, a meter in diameter, electric waves nearly 150 centimeters in length will be emitted and though these latter waves are invisible to the eye, they are as truly electromagnetic in character as light waves. This was the mathematical theory of Maxwell, but like the deductions of Von Helmholtz it required verification by actual experiment. This was forthcoming in 1888, when Heinrich Hertz succeeded in producing electromagnetic waves (to which he subsequently gave the shorter name of electric waves) standing in free space and gliding over wires; he showed that they could be reflected, refracted, polarized, diffused, and generally followed optical laws just as though they were light waves. This achievement was the first real advance toward the art of wireless telegraphy.

As a detector of electric waves at a distance from whence they were emitted, Hertz employed a circlet of wire having an air gap in it of microscopic size; this he termed a "resonator." The distance to which waves could be detected with it was very limited, but it served Hertz's purpose admirably. The next step toward electric-wave transmission without wires was made in 1890, when Edouard Branly, in a course of experiments showing the "variations of conductivity under electrical influence," found that metal filings placed in a tube having terminal conductor plugs was marvelously sensitive to feeble oscillations set up by impinging electric waves, and to this electric

eye he gave the name of *"radio-conductor"*; Lodge renamed it *"coherer."*

The first apparatus having all the essentials of a modern wireless-telegraph receiver was designed by Prof. Popoff in 1895, but was employed by him as a meterological detector of distant storms, registering their presence by means of electric waves, emitted by the lightning, impinging on a vertical wire connected with the ground through a coherer. The first practical transmitter for wireless telegraphy was



H. M. S. ABOUKIR, EQUIPPED WITH MARCONI APPARATUS.

constructed by Marconi in 1896, when he added a vertical wire to one arm of an oscillator and grounded the opposite arm, making it the physical counterpart of his resonator, which was designed on the same general lines as the receiver of Popoff. This brings the history of the art to the time of its commercial solution. From this period to the present date, new workers, with one exception, have been responsible for the systems herein described. These systems have been designed not only to cover extreme distances, but also to render possible the selective interchange of messages, or syntonic wireless telegraphy.

Theoretical:—The theory of the propagation of electric waves over long distances has been the subject of considerable recent discussion in the United States, but fortunately this phase of Max-

well's deductions does not enter into the practice of wireless-telegraph engineering to any great extent; a brief outline of the two principal conclusions which have been reached, and the solution of the acting referee, will serve, however, to show the trend of opinion upon this subject.

Any theory advanced must conform with Maxwell's conceptions and the experiments of Hertz, but as the fundamental equations by which Maxwell evolved his theory are as broad as they are beautiful, its interpretations by various technicians are widely divergent, and the final solution is rendered all the more difficult when Hertz's work is consulted; for he not only observed electric waves in free space, but waves which traverse the surface of wires as well.

The first of these theories is based on Hertz's experiments embodied in his paper "On the Propagation of Electric Waves by Means of Wires," in which he shows how transverse electrical displacements, or sliding waves traveling over a conducting wire, may be produced; or, to quote Hertz's own words, "the electric force which determines the current is not propagated in the wire itself, but under all circumstances penetrates from without into the wire, and spreads into the metal with comparative slowness and according to laws similar to those which govern changes of temperature in a conducting body." This is due to the inductance, and when the frequency of the current is of the order of millions per second, by virtue of the opposition inductance offers to such high frequencies, the current must flow on the surface of the wire."

On the assumption that the earth is a perfect conductor, Prof. Reginald Fessenden and others elucidate the theory of wireless transmission based on the postulate of semi-free and half waves. These are caused by the electric waves which stream from the antennae to the earth and, striking it, are detached and the half waves skim over its surface as in the case of Hertz's experiment just cited. To complete this theory it is further assumed that the opposite arm of the oscillator —which is grounded—does not emit waves, and that the opposite half of the wave is mythical, like the reflection of an object in a mirror.

The second theory is that advanced by the author and others, and accounts for the rectilinear propagation of electric waves in accordance with Hertz's physical demonstration of Maxwell's elecromagnetic theory of light. In his paper "On Electric Radiation," Hertz showed how free electric waves or transverse vibrations of the ether—identical with light waves, but longer—may be made to follow all the known laws of light.

This theory is based on the assumption that electric oscillations, surging with high frequency through the oscillator system formed by the antennae and the earthed terminal, emit free electric waves which are propagated through space just as are light waves by the vibratory charge of electricity on gaseous atoms. Where the curvature of the earth intervenes, it is assumed the waves are reflected like the rays of the sun producing twilight and dawn.

As a balm to the contending parties in these opposition theories, Dr. Arthur E. Kennelly asserts that both are right, by showing how the emitted wave not only traverses space in the form of transverse vibrations, but that portion of it which comes in contact with the earth slides over it.

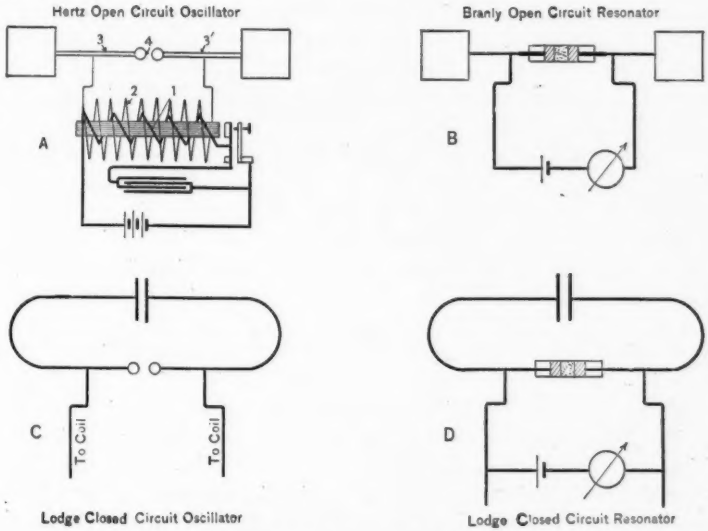


FIG. I. DIAGRAM ILLUSTRATIVE OF APPARATUS FOR PRODUCING AND RECEIVING ELECTRIC WAVES.

The theory involving the method of producing and receiving electric waves is much more easily defined. The apparatus consists essentially of three electric circuits, shown in Fig. 1, A B C D; 1 A represents the inductor or primary winding of a Ruhmkorff coil, and 2 the secondary winding, in which low-frequency high-potential currents are set up; 3 3′ is the oscillator wherein the high-potential charge is transformed into electric oscillations of enormous frequency by means of the disruptive discharge taking place in the spark gap, 4. These three

circuits may be regarded as entirely distinct and separate from the other, for, though the oscillator is connected directly to the terminals of the secondary, the latter is employed merely to charge the oscillator 3 3′ to a potential high enough to break down the air gap, 4; the great inductance of the secondary causes it to choke the oscillations, rendering the secondary impervious to it.

Again, the oscillator system may be of either the open-circuit type, Figure 1 A, or closed-circuit type, Figure 1 C. Lodge has shown that whereas the open-circuit oscillator is a most excellent emitter of waves, though these are damped out very rapidly, the function of the closed-circuit resonator is diametrically opposite, in that the oscillations are exceedingly persistent but are emitted very feebly. Therefore the open-circuit oscillator is pre-eminently the best adapted for long-distant transmission, whereas the closed circuit is at once commendable for resonance effects in syntonic systems. Likewise the resonator of the receiver may be of either the open- or closed-circuit type, as shown in Figure 1, B and D.

The frequency of the oscillations in either case depends on the coefficients of the circuit; these are its inductance, capacity, and resistance. Inductance finds its analogue in mechanical inertia, for a current requires time for its acceleration in a conductor and time for its retardation. The capacity of an oscillator system is determined by the quantity of electricity required to raise its potential to the critical value where the charge will disrupt the air gap at 4, and depends not only on the dimensions of the oscillator but the potential which is impressed upon it. The ohmic resistance of an oscillator is in reality exceedingly small, that is to say that it is *less* than the square root of the inductance divided by the capacity, and may be likened to the mechanical action of friction; therefore the current describes a curve that is periodic and alternate with maxima gradually decreasing in geometric progression; but if the resistance is imaginary—that is, if it is *greater* than the square root of the inductance divided by the capacity—there can be no oscillations and the current will be continuous and unidirectional.

In simple wireless telegraph systems these coefficients are of little importance; all that is needed is a good emitter, as the length of the wave may vary within wide limits without ill effects. But in syntonized systems they are at once mighty factors, for by adjusting their values the oscillator and resonator may be attuned or syntonized to each other as in acoustic resonance, the emitted waves of the former setting up counter-oscillations in the latter of identically the same frequency, while if waves are emitted by an oscillator having a periodicity

different from that of the resonator there will be no response, since the effect of increasing the inductance and capacity of the circuits is to slow down the frequency of the currents, and in turn longer waves are emitted. Again, the frequency of the oscillations may be stepped-up or stepped-down by transformers, following exactly the same laws as alternating currents in general.

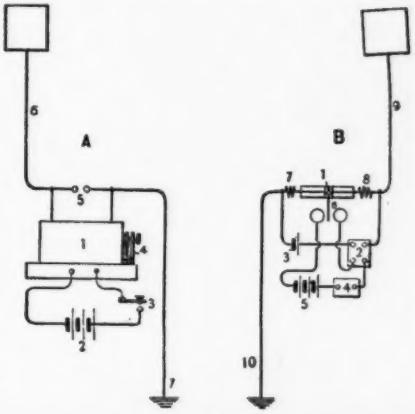


FIG. 2. DIAGRAM OF ORIGINAL MARCONI TRANSMITTER AND RECEIVER.

Practical:—Based on the preceding theoretical deductions wireless telegraph apparatus may be divided into two general classes: (a) those constructed on non-syntonic lines, designed simply to cover long distances; and (b), those contrived to fulfill the laws of electrical resonance, or syntonic systems for individual selective telegraphy.

The first practical electric-wave system was, as a matter of evolution, of the non-syntonic class. In Figure 2, a diagram of the original Marconi transmitter and receiver is shown. By comparing it with the Hertz apparatus, Figure 1 A, it will be seen that the only difference lies in the extension of one of the oscillator arms forming the antenna and grounding the opposite arm. The Marconi receiver is similar to the one invented by Popoff, and is the counterpart of the transmitter in that the resonator consists of a vertical wire as well as an earthed terminal and connected in series with a coherer; the oscillator and resonator are therefore, of the open-circuit type.

Referring to Figure 2, A; 1 represents an induction coil, 2 a source of current, 3 a key for arbitrarily making and breaking the current, 4 an automatic interrupter, 5 the spark gap of the oscillator, 6 the antennae, and 7 the earthed connection: The component parts of the receiver are depicted at B; 1 shows the coherer, 2 a polarized relay operated by the single cell 3 in series with 1, 2; an auxiliary circuit includes the Morse register 4, the writing contacts of the relay 2, the battery 5, and the decohering tapper 6; two small inductance coils 7, 8, are interposed between the coherer and the relay to intercept the miniature

trains of electric waves set up by the minute sparks taking place between the platinum points of the working contacts upon breaking the auxiliary circuit; the resonator is formed by the antenna 9, and the earthed terminal 10. By this apparatus Marconi sent signals in London in 1896 a distance of 300 feet, and by constantly improving the sensitiveness of the receiving devices, by increasing the height and number of the antennae, and employing transmitters of greater power, he succeeded in transmitting readable messages a distance of nearly 2,000 miles in 1902.

The equipment Marconi employed in the days of his earliest successes, when he telegraphed across the English Channel, is illustrated in Figure 3. The transmitter is shown to the extreme right and the receiver to the left; the coherer and all other parts of the apparatus sensitive to electric waves are placed in metal boxes, to exclude extra-

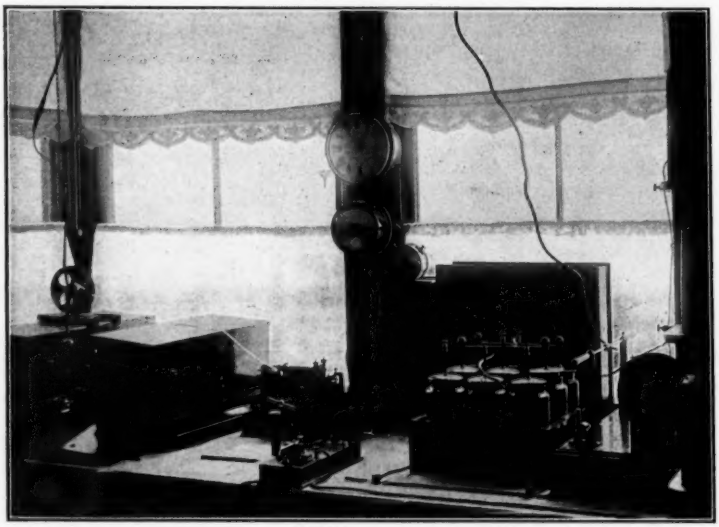


FIG. 3. INSTRUMENT ROOM, NORTH FORELAND STATION, MARCONI SYSTEM.
The station from which the earliest successful signalling across the English Channel was done.

neous waves and prevent injury to the delicate adjustments when the powerful oscillations of the transmitter are taking place. The boxes are connected with the ground and all waves not received by the antennae are conducted to the earth and there dissipated.

But Marconi has been assiduous, not only in developing long-distance wireless transmission, but also in evolving a system which has

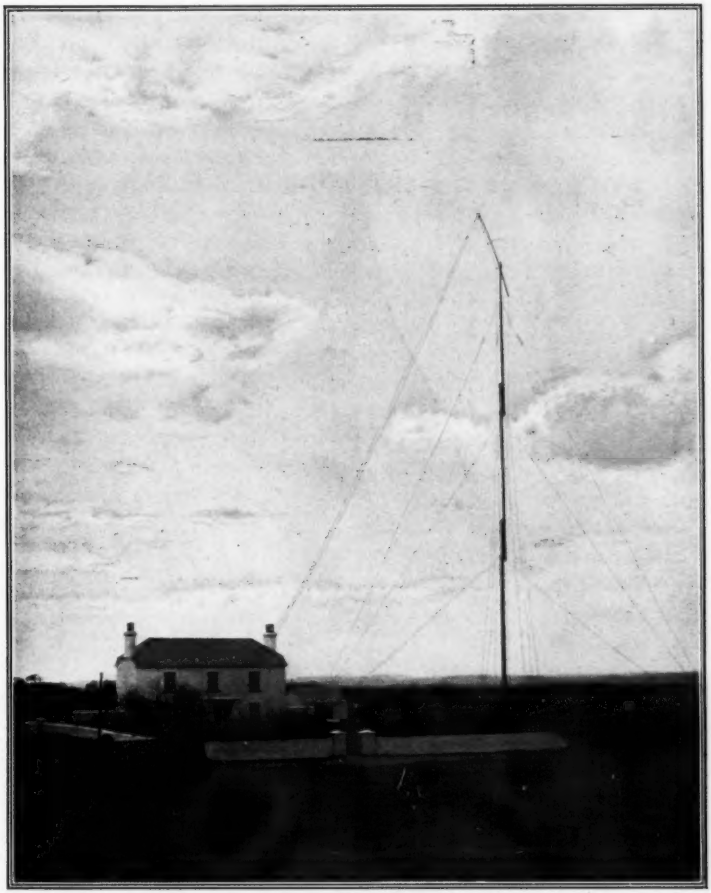


FIG. 4. MARCONI SHIP-SIGNALLING STATION AT ROSSLARE, ON THE SOUTHEAST COAST OF IRELAND.
Showing mast and antennae leading to instrument room.

for its object individual selective signalling; in this new appartus the inventor has compounded the open- and closed-circuit oscillators and resonators, and thereby obtained the maximum penetrative efficiency of the emitted waves, and retained at the same time the maximum persistency. This syntonic system is shown diagramatically in Figure 5; 1, 1′ represent two copper cylinders employed instead of the usual antennae in the transmitter and receiver. These are connected to earth

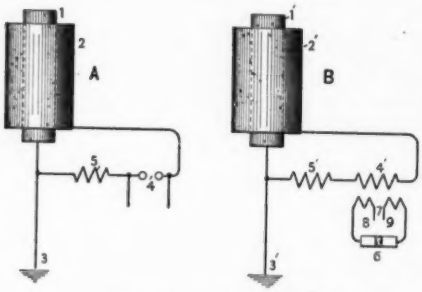


FIG. 5. DIAGRAM OF MARCONI SELECTIVE WIRELESS-TELEGRAPH SYSTEM.

at 3, 3'. Surrounding these cylinders are two metal cylinders of larger diameter, mounted in such a manner that an air space intervenes between them. In the transmitter (A) the outer cylinder is connected to one side of the spark gap 4, the opposite side terminating in the inner cylinder; 5 is a variable inductance; in the receiver (B) the two cylinders are connected through the primary by a small transformer coil 4' and inductance coil 5'; the coherer 6 receives its impulses through the secondary of the transformer 7, the object of this arrangement being to allow the static differences of potential of the earth and outer cylinder to be equalized and not interfere with the coherer. The action of the instruments resembles that of two Leyden jars with closed circuits; when the disruptive discharge takes place in the air gap 4, the oscillations surge to and fro many times in the compound circuits before they die away; the waves emitted, though retaining somewhat the strength of those propagated by the open-circuit oscillator, form trains of waves, and these, impinging on the resonator circuit, set up oscillations which, though feeble at first, grow stronger through resonance until the potential difference impressed upon the terminal plugs of the coherer is raised to a value where it breaks down the minute insulating film of air separating the filings, and cohesion takes place. The local circuit containing the relay is attached to the termi-

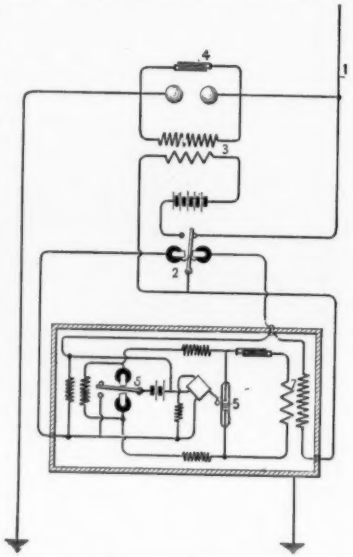


FIG. 6. GUARINI REPEATER.

1, antenna; 2, relay or aerial switch; 3, induction coil; 4, condenser, parallel to spark gap; 5, coherer; 6, relay; 7, transformer coil.

nals of the transformer coil 8, 9. Theoretically the values of inductance may be varied by the adjustable coils, 5, 5′, and the capacity changed by increasing or diminishing the dimensions and therefore the capacity of the cylinders. Another advance toward syntonization is due to Marconi, who has devised a new magnetic electric-wave detector—that is to say, the coherer is supplanted by a detector based on a new principle. This detector is made by winding a layer of fine insulated wire on a core of soft-iron wire; the terminals of this coil are connected with the antenna and earth respectively; over this is wound a second layer of the same sized wire, and these terminals are connected in series with a cell and telephone receiver. A magnet, operated by clockwork, revolves before the poles of the core and pro-

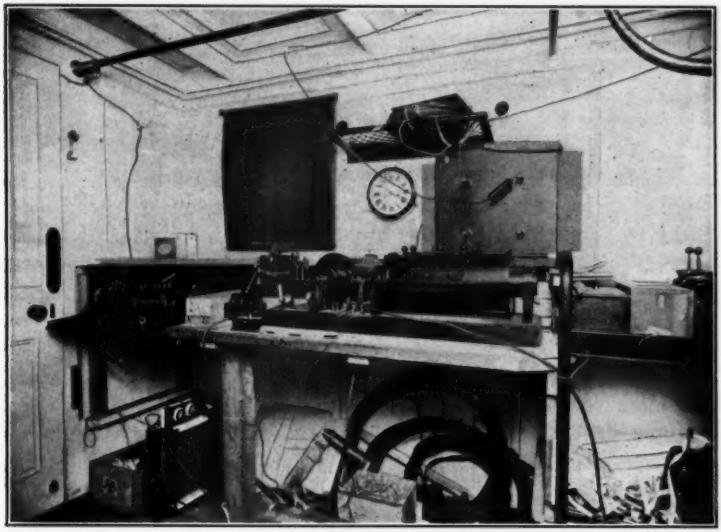


FIG. 7. MARCONI SELECTIVE WIRELESS-TELEGRAPH SYSTEM. STANDARD STATION SET ON S. S. PHILADELPHIA.

duces in it hysteresis by constantly increasing and decreasing magnetism, and by means of this cyclic change every oscillation set up in the primary coil by the impinging electric waves is marvelously accentuated. This detector is not only self-restoring, but its value in syntonic wireless telegraphy lies in the fact that its resistance is practically constant, whilst the coherer is always variable.

A series of clever experiments were made in 1901 by M. Emile Guarini Foresio and his colleague, Artillery Lieutenant Poncelot of

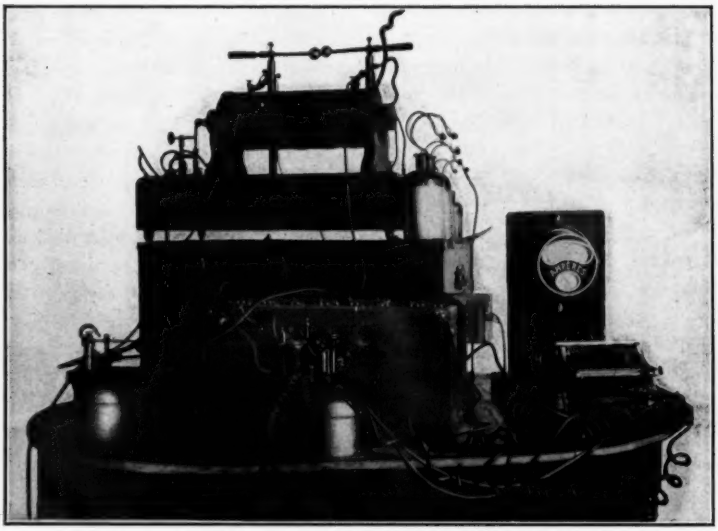


FIG. 8. GUARINI AUTOMATIC REPEATER.

Brussels, Belgium, in repeating automatically wireless-telegraph messages. At Antwerp and at Brussels, 25 miles apart, two standard station installations were made, whilst at Mechlin, a village situated midway between the two cities, Guarini's automatic repeater was employed to relay the messages. In wireless telegraphy the antenna is cut off from the receiver when the transmitter is in operation, and when messages are received this is reversed. It is evident that in a repeater this must be done automatically; the combination apparatus is shown diagramatically in Figure 6. Figure 8 shows photographically the method employed by Guarini for receiving the enfeebled waves and for all the subsequent translations from the coherer until the powerful re-energized waves are an instant later emitted from the same antenna.

A single antenna, 1, is connected to a relay, 2, of special construction, termed an aerial switch, and having double contact points; when the armature of this relay is drawn to the right, the receiver is placed in electrical connection with the antenna, and when thrown to the left the induction coil, 3, is set in action; 4 represents a condenser in parallel with the spark gap. A regenerable Blondel coherer, 5, is in series with an exceedingly sensitive relay, 6, and these, with the necessary inductance coils, are included in a metal box as previously described. The primary of a small transformer, 7, is connected to the antenna and

led to earth through the metal box; when the oscillations surge through the primary they are impressed upon the secondary of the coil, and this being in series with the coherer produces a potential difference in the latter which in turn causes the filings to cohere. The value of repeating wireless messages cannot be over-estimated, and it is only a question of time when the great trans-Atlantic service will be equipped with repeaters, enabling continuous communication to be kept up between England and the United States.

The Popoff-Ducretet apparatus is based upon a memoir presented at the Paris Congress of Electricity by Prof. M. A. Popoff and the observations of M. E. Ducretet. The transmitter is constructed on orthodox lines and is the result of Ducretet's mechanical ability as an instrument maker. It consists of a regulation induction coil, an electromagnetic interrupter and oscillator of the Righi type, with the spark balls immersed in vaseline oil. The antenna is connected direct to one side of the spark gap and the earth to the opposite side.

The receiver of Popoff differs from those described in that it employs a self-righting coherer; this type of coherer generally contains carbon granules instead of silver and nickel filings, and its normal resistivity is restored without tapping or other device to effect decohesion. In receiving messages the antenna is connected to one of the conductor plugs of the coherer and the earth to the opposite one. The local circuit includes a single cell and a pair of head telephones, and the messages are read by the operator through the vibrations of the diaphragms of the telephone receivers, which respond to every change of the coherer. This type is much more sensitive than a metal-filings coherer, and as the energy required to operate a telephone receiver is hundreds of times less than for the most sensitive relay, the Popoff instrument is extremely valuable for receiving messages at greater distances from the transmitter than is possible with the more complicated apparatus utilized in the standard station sets. The Ducretet transmitter is similar to Figure 2, A, and the Popoff receiver to Figure 1, B, execpt that in the latter the antenna and earth are connected to the coherer.

Señor Cervera, on behalf of the Spanish government, has designed a wireless-telegraph system that is, in some respects, different from those which preceded. While the transmitter of Cervera employs a vertical wire and grounded terminal of the open-circuit type, a condenser is inserted in either arm of the oscillator near the spark gap to increase the potential of the discharge. The receiver operates through the same antenna and ground wire as the emitter, but the changing

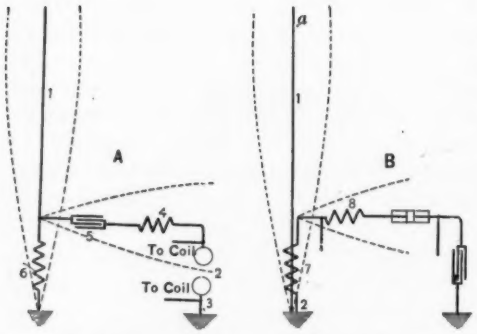


FIG. 10. DIAGRAMATIC VIEW OF SLABY-ARCO MULTIPLE-TUNED WIRELESS-TELEGRAPH TRANSMITTER AND RECEIVER.

switch is so arranged that the condensers are cut out when receiving. The distinguishing features of this apparatus are principally in the construction of the receiver. The antenna and earth are connected through the primary of a small transformer, the secondary of which is divided by cutting one convolution at the center and connecting the terminals thus formed to a condenser, and this in turn to the conductor plugs of the coherer.

The coherer consists of two small parallel ivory discs, adjusted by means of micrometer screws, and between them are the conductor plugs made of soft annealed iron forming the contacts with the powdered metal. There are four separate circuits in the Cervera receiving apparatus, each having its own source of current, and these fulfil the following functions:—(a) operating the Morse register; (b) making and breaking the coherer and relay circuit, rendering decohesion more certain; (c) actuating the tapper; and (d), interrupting the circuit of an electromagnet regulating the sensibility of the coherer. The receiving circuits are more complicated than in any other system, but the apparatus works well and has given satisfaction between testing stations at Tarifa, Mount Comorro, and Ceuta at the Castle of Huelvo across the Strait of Gibraltar, a distance of 34 kilometers.

The Slaby-Arco multiple-tuned wireless-telegraph system is based on a number of original conclusions bearing on the laws of electrical resonance. Dr. Slaby and Count Arco begin by assuming that the height of the antenna should be one-fourth the length of the emitted wave, and instead of connecting the antenna to the side of the spark gap it is grounded direct as shown in Figure 10, A; a second conclusion is that the earth forms a nodal point for the current waves, and this being accepted it is plain that a second wire equal in length to the antenna and connected to it in the earth will respond to the current waves and a wave crest or its greatest amplitude at the end of the wire equal to that at the end of the antenna, as shown by the dotted lines.

The second or auxiliary wire does not need to be of the same length, physically, as the antenna, but must represent the same inductance, capacity, and resistance; the spark gap, 2, of the induction coil is connected to one terminal of the auxiliary wire and the opposite side grounded at 3; an inductance coil 4, and condenser, 5, both of which are adjustable, serve to make it of the same dimensions, electrically, as those of the antenna. The large inductance coil, 6, serves to regulate the fundamental harmonics of the open-circuit oscillator, 1. The resonator, B, is similar to the oscillator, A, and all waves not of predetermined length are dissipated in the earth, since the nodal point would not be at the juncture of the auxiliary wire; in the receiver this wire terminates in the coherer, the opposite conductor plug of which is earthed; the coils 7 and 8 are inductances for the purpose of tuning the

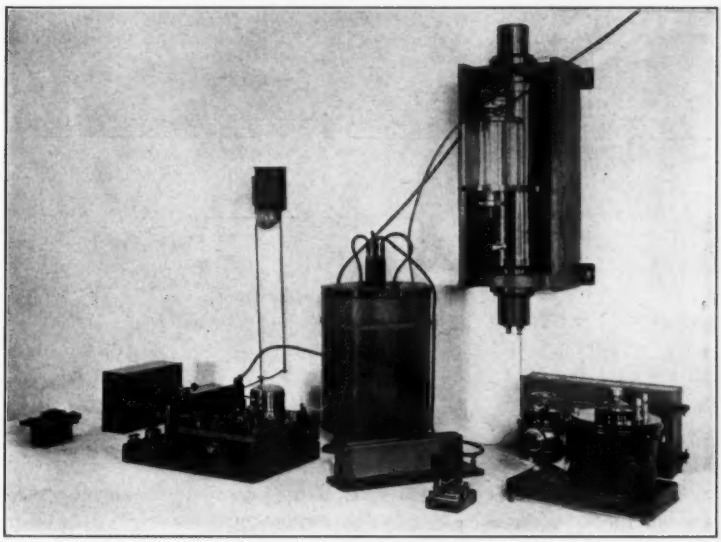


FIG. 11. SLABY-ARCO MULTIPLE-TUNED WIRELESS-TELEGRAPH APPARATUS. STANDARD STATION SET.

system, which is compounded, embodying both the open and closed-circuit oscillators and resonators, but the dividing line between them is not very well defined.

In the photograph, Figure 11, a complete standard station set is shown; the induction coil with the oscillator, encased in a glass vessel filled with oil, is fastened to the wall; the primary current, supplied from 110-volt circuit, is passed through a mercury turbine interrupter

operated by a small motor, shown to the right; a key and variable resistance completes the transmitter. In practice the inductance coil (4, Figure 10) consists of a few turns of heavy wire wound on the outside of the condenser, 5, made up, in this case, of a number of Leyden jars (Figure 11) enclosed in a cylindrical pasteboard box. A relay, coherer, tapper, and Morse register form the principal elements of the receiver, whilst a bell, arranged in parallel with the Morse register, serves to call the operator. This system was exhibited before the German Emperor when two messages were received simultaneously from different stations.

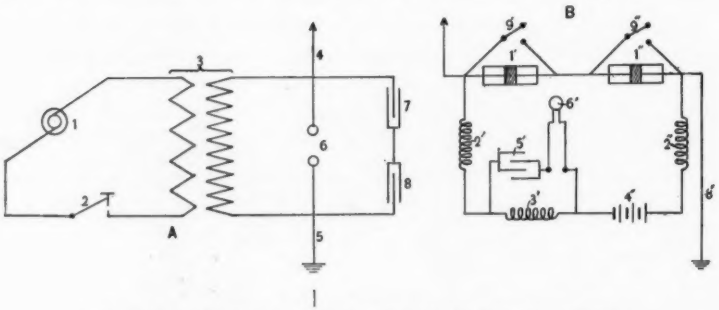


FIG. 12. DIAGRAM OF DE FOREST WIRELESS-TELEGRAPH SYSTEM.
A, transmitter; 1, alternating-current generator; 2, key; 3, oil transformer; 4, antenna; 5, ground; 6, spark gap; 7, 8, condensers. B, receiver; 1′, 1″, responders; 2′, 2″, choke coils; 3′, resistance 5,000 ohms; 4′, battery; 5′, condenser; 6′, telephone receiver; 7′, antenna; 8′, ground; 9′, 9″, shunt switches.

The De Forest wireless telegraph is an American system designed by Dr. Lee De Forest and Prof. Clarence E. Freeman, and contains several novel features. The transmitter is widely different in its construction from those employing induction coils of the Ruhmkorff type, in that a 110-volt current is transformed by a rotary transformer into an alternating current at 500 volts and this is stepped-up in an oil transformer to 25,000 volts; a condenser formed by a number of Leyden jars is charged to their maximum capacity by this low-frequency high-potential current, and the high-frequency high-potential currents are obtained by the disruptive discharge of the jars through an oscillator having the usual air gap. Figure 12, A, shows the connections of the transmitter. The antenna is connected to one side of the oscillator and the earth to the opposite side. A key for breaking the primary circuit under oil has been designed especially for high-speed work. A photograph of the sending apparatus is shown in Figure 14.

The De Forest receiver employs a detector of the electric waves

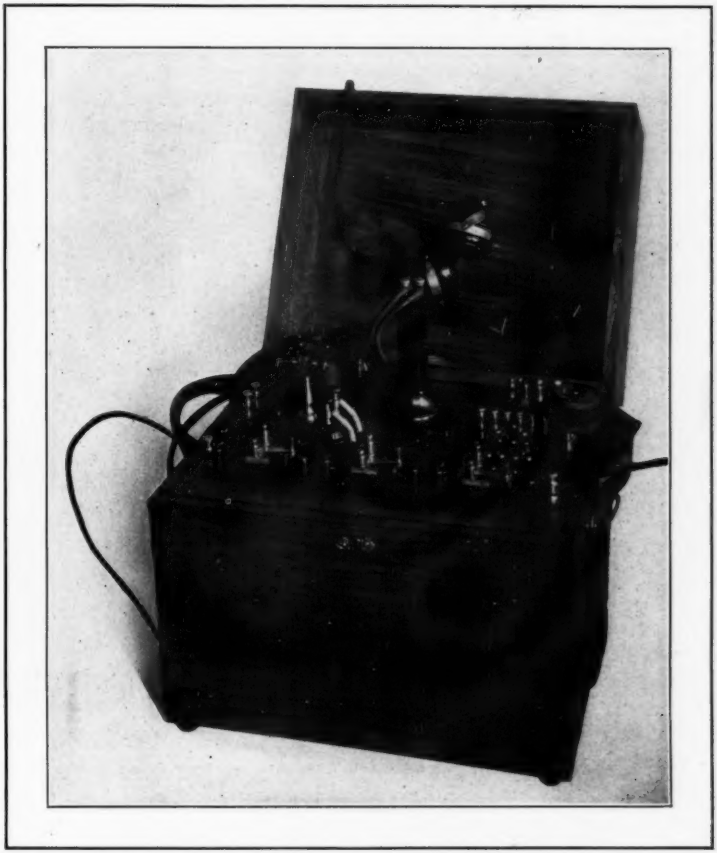


FIG. 13. DE FOREST WIRELESS-TELEGRAPH RECEIVER WITH TRIPLE RESPONDER AND HEAD TELEPHONES.

which responds to the impressed difference of potential in a manner similar to an anti-coherer, and diametrically opposite to that of an ordinary coherer; that is, it has its resistivity increased, but unlike the anti-coherer, the responder of De Forest has an internal action due to electrolysis. Unlike the receiver of Popoff-Ducretet, the circuit including the head telephones, responder, and cell of the De Forest receiver has a nominally closed local circuit, the current from the cell flowing through the telephones all the time the instrument is in operation. When the impinging wave sets up its complementary oscillation,

the latter acts upon the responder and instantly its resistance is increased, the local circuit is broken, and the diaphragm, released from the pull of the magnets, produces a sharp click. In Figure 12, B, it will be observed that the antenna and earth are connected to the primary of a small transformer and the responder, cell, and telephone, forming the local circuit, are connected in series with the secondary of

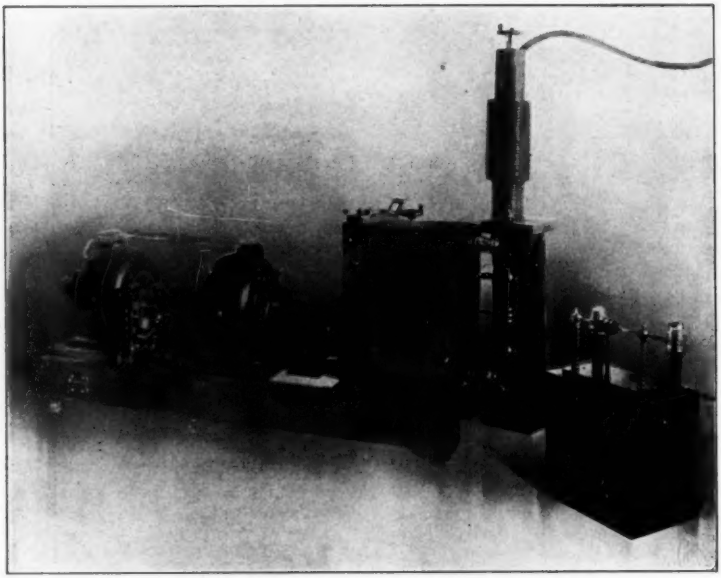


FIG. 14. DE FOREST WIRELESS-TELEGRAPH TRANSMITTER;
Showing rotary transformer, oil transformer, condensers, spark gap, and key.

the transformer. This system has been very successful and this is, no doubt, largely due to its simplicity of construction. At the Jersey City station on February 22, 1902, signals were received from the Etruria when the steamer was ninety miles at sea.

In a series of patents issued to Prof. Reginald A. Fessenden, one of especial interest includes the principal features of his improvements in wireless telegraphy. The diagram, Figure 15, shows a combined sending and receiving apparatus, 1 representing the antenna, 2 an induction-coil generator, 3 a spark gap, 4 a key to throw the antenna in and out of tune, the generator being kept continuously in action, 5 a tuning device or grid formed of one or more movable contacts, shown in 6 in electrical contact with each pair of wires; these are immersed in oil.

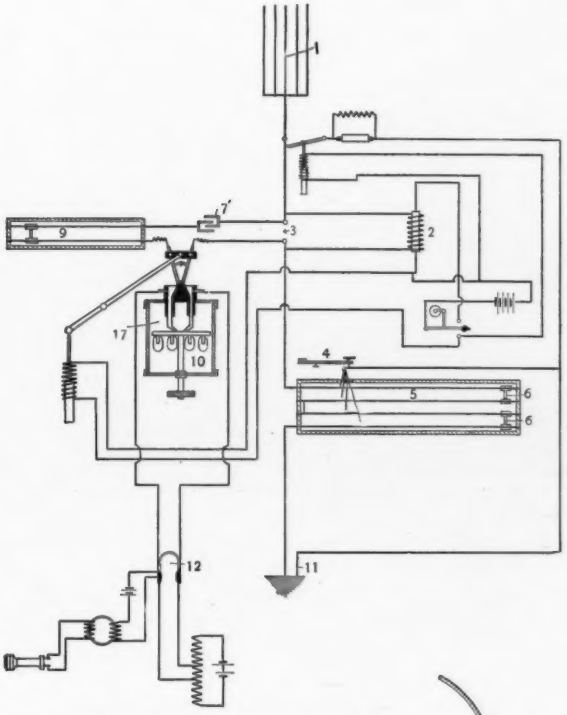


FIG. 15. FESSENDEN COMBINED SENDING AND RECEIVING APPARATUS.

The tuning grid is novel in its construction in that it combines a variable inductance and capacity without resorting to coils, condensers, or capacity areas. By adjusting the capacity and inductance, a frequency of oscillation may be obtained which exactly corresponds to the natural period of the oscillator system—which includes the antenna—and a pure sine wave is the result.

The resonator of the receiver includes the antenna 1, the condenser 7, tuning grid 9, electro-magnetic-wave detector 10, and the earth 11. The tuning grid is similar to the one employed in the oscillator system.

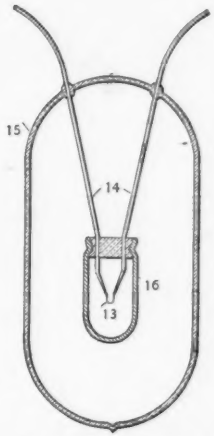


FIG. 16. FESSENDEN ELECTRIC-WAVE DETECTOR.

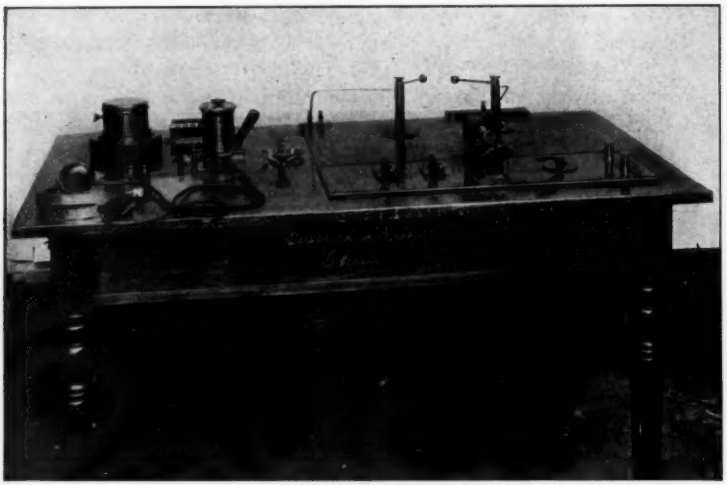


FIG. 17. RECEIVING AND TRANSMITTING APPARATUS, FESSENDEN WIRELESS-TELEGRAPH SYSTEM.

That a high speed may be obtained in receiving, Fessenden employs a pair of head telephones 12, and the detector 10, which possesses decided advantages over an ordinary self-restoring coherer, not only in being more rapid in action, but in its economical function whereby all of the energy of the received wave is utilized.

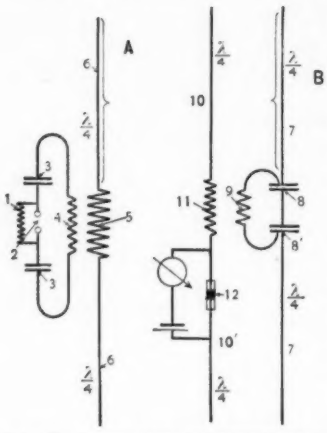


FIG. 18. SCHEMATIC ARRANGEMENT OF BRAUN'S WIRELESS-TELEGRAPH SYSTEM. A, receiver; B, transmitter.

The electric-wave detector, 10, is shown in detail in Figure 16; it is composed of a short loop of silver wire, 13, having a diameter of .002 inch, with a core of platinum wire .00006 inch in diameter and fastened to the leading-in wires, 14, these, in turn, being sealed in the glass bulb, 15. The tip of the silver loop is dissolved away by nitric acid, leaving the platinum exposed, and to decrease the loss by radiation the loop is enclosed in the silver shell, 16. The device shown at 17, Figure 15, is a holder for a number of the wave detectors just described.

Figure 17 is a photograph of the Fessenden apparatus complete, the oil break of the key and nearly all the receiving apparatus being enclosed beneath the table. This system has been thoroughly tested by the U. S. Weather Bureau, of which Prof. Fessenden has been the wireless-telegraph engineer for the past few years.

One of the best-known, though recent, systems, is that designed by Dr. F. Braun. The apparatus typifies the accrued knowledge of oscil-

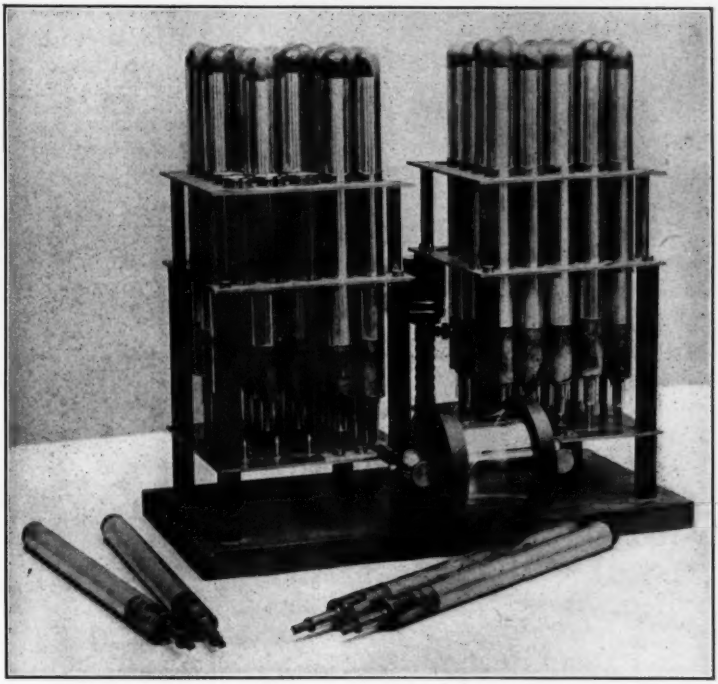


FIG. 19. BRAUN-SIEMENS & HALSKE VARIABLE-CAPACITY SPARK GAP FOR OSCILLATOR SYSTEM.

lations, electric waves, and resonance, combined with the most advanced mechanical ideas and the finest workmanship.

A diagramatic arrangement of the oscillator and resonator systems is shown in Figure 18, A B. 1 represents the secondary winding of an induction coil, 2 the spark gap, 3, 3′ condensers, and 4 the primary of a high-tension transformer, the whole forming a closed circuit in which very persistent oscillations are produced; 5 is the secondary of the transformer, whose terminals are connected with two conductors 6, 6′,

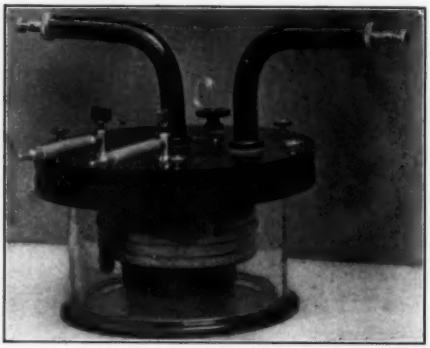


FIG. 20. BRAUN HIGH-TENSION TRANSFORMER FOR HIGH-FREQUENCY OSCILLATIONS.

both of which are one-fourth the length of the emitted wave, and forming an open-circuit oscillator system emitting powerful oscillations.

The receiver, B, consists of two vertical wires, 7, 7′, one of which is the antenna, both one-quarter the length of the received wave, and forming a closed-circuit resonator through the condensers, 8, 8′, and the primary winding of the transformer, 9; two auxiliary wires, 10, 10′, having the same length as 7, 7′, are connected to the terminals of the secondary of the transformer, 11; in one of the wires a coherer, 12, is included and from this local circuit is derived. This is the only practical system in which the earth is eliminated as a factor for tuning, capacity areas in the form of concentric cylinders being employed instead, and these make syntonic wireless telegraphy a practical fact instead of a theoretical fancy.

When in action the apparatus performs the following functions; the

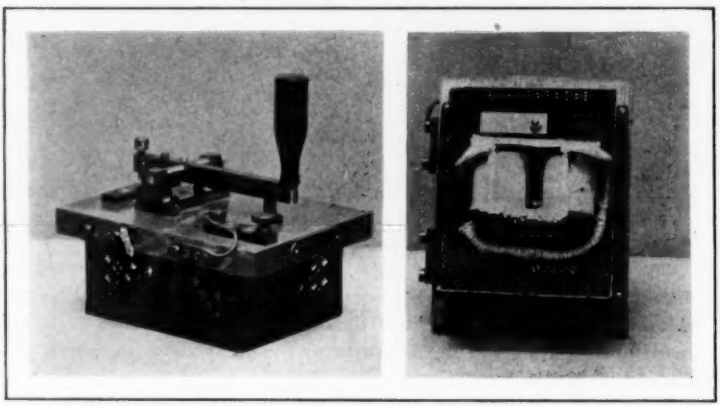


FIG. 21. THE FIGURE ON THE LEFT (a) SHOWS THE BRAUN KEY FOR BREAKING HEAVY CURRENT. THAT ON THE RIGHT (b) GIVES THE UNDERNEATH VIEW OF THE KEY, SHOWING THE MAGNETIC BLOW-OUT.

secondary of the induction coil charges the closed oscillator circuit after each disruptive discharge takes place, and the persistent oscillations thus set up are transformed into any frequency desired in the open-circuit oscillator, from which the waves are emitted very freely; the waves impinging on the closed-circuit resonator produce counter-oscillations of fundamental frequency, and these are transformed into the open-circuit, where their amplitude becomes greatest, and produce the difference of potential necessary to act on the coherer.

The accompanying photographs of the Braun system illustrate the apparatus for producing these effects. Referring to the diagram the

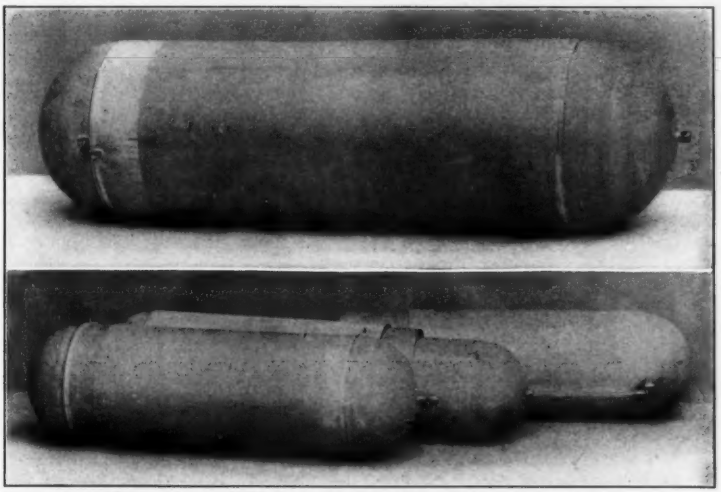


FIG. 22. CAPACITY AREAS, BRAUN-SIEMENS & HALSKE SYSTEM.
One arm of the oscillator and resonator is connected with these, instead of being grounded in the usual way.

condensers 3 3′ are arranged on a stand (Figure 19) and consist of a series of miniature Leyden jars; by this arrangement an adjustable capacity is produced; the spark gap, 2, is formed between two metal balls immersed in oil contained in the glass cylinder attached to the front of the condensers.

In Figure 21, a, b, are two views of the Morse key designed for breaking heavy currents, the spark of the break due to heavy currents being eliminated by the magnetic blowout shown in b. The high-tension transformer appears in Figure 20; this gives clearly the construction of this simple but highly ingenious piece of apparatus for stepping-up oscillatory currents as depicted diagramatically at 4, 5,

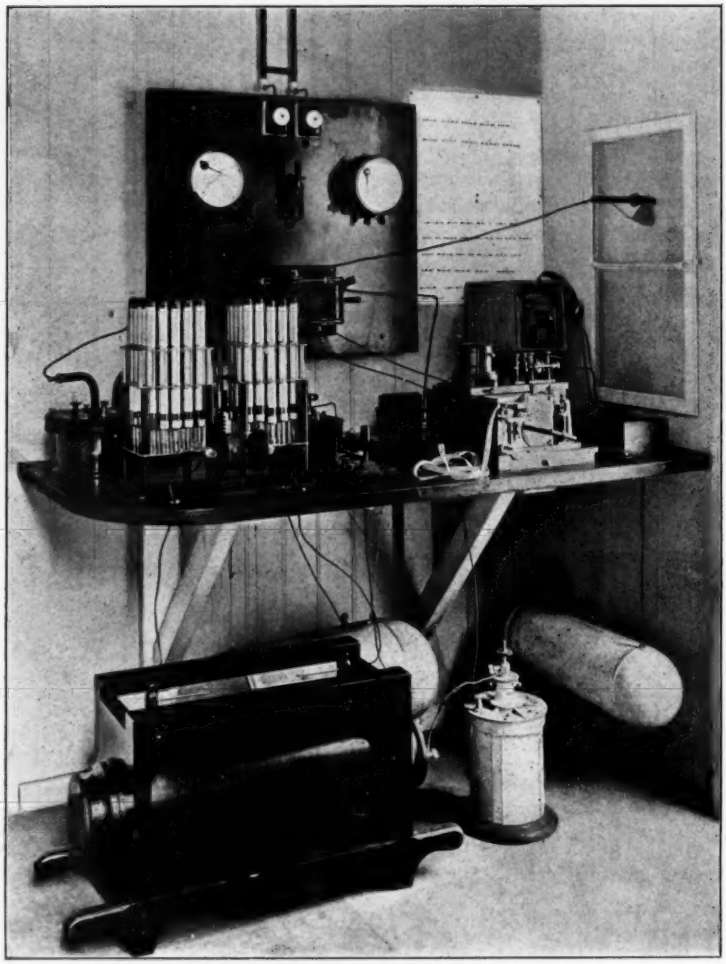


FIG. 23. BRAUN-SIEMENS & HALSKE WIRELESS-TELEGRAPH EQUIPMENT. STANDARD STATION APPARATUS.

Figure 17. The jar of the transformer contains oil when the coil is in action.

The capacities employed to take the place of the earth depicted in Figure 22 are made of copper or zinc, usually of two parts, sliding within each other, thus offering a variable capacity. The complete

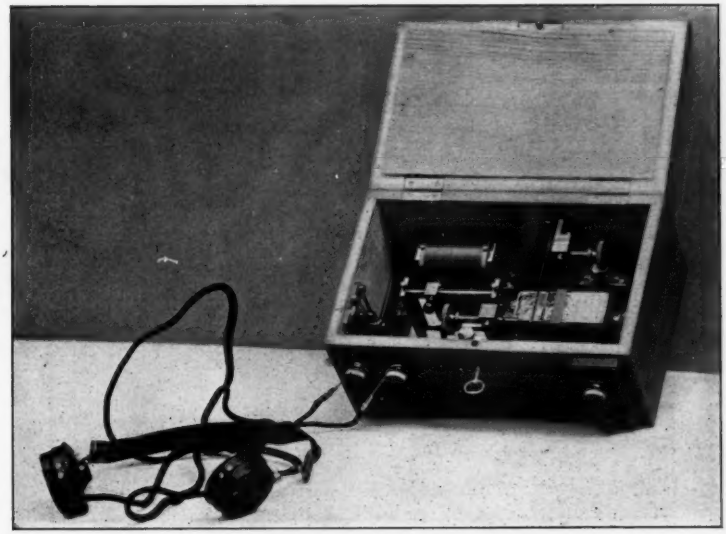


FIG. 24. THE BRAUN FIELD RECEIVER.

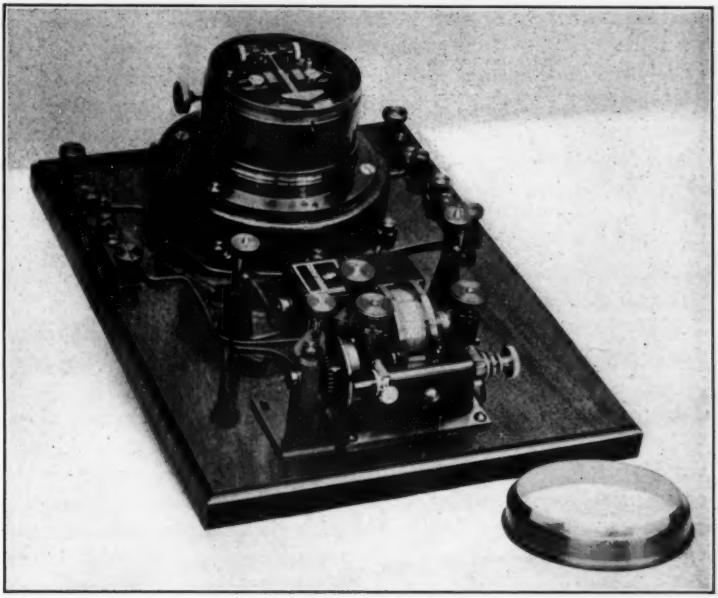


FIG. 25. BRAUN-SIEMENS & HALSKE POLARIZED RELAY ELECTRO-MECHANICAL TAPPER AND COHERER.

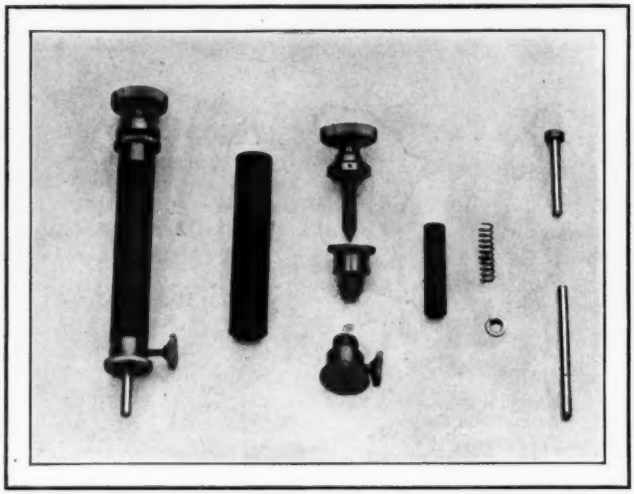


FIG. 26. THE BRAUN COHERER AND ITS COMPONENT PARTS.

sending and receiving system for a standard station is shown set up for testing prior to shipment in Figure 23, and the connections are so clearly defined they may be followed almost as easily as in a diagram. The induction coil with its accompanying electrolytic interrupter—on the floor—is operated by 110-volt current leading in to the switchboard. The secondary is connected directly to the spark gap. The large switch is for the purpose of cutting in and out the antenna from the transmitter and receiver. The small transformer for the receiver, the relay, mechanical tapper, coherer, and Morse register complete the equipment. Braun's system has met with flattering success between Helgoland in the German Ocean and Cuxhaven, a distance of 36 miles.

This represents the state of the art and the practice of signalling through space without wires to the present time. In conclusion, it is interesting to note that the letter "S" was sent and received across the Atlantic Ocean wirelessly, and that messages have been transmitted and recorded between two stations, which could not be received, intercepted or annihilated by a third station; at present the difficulties in the commercial use of such long-distance transmission and syntonic systems are many; but it portrays with vividness the ultimate scope wireless telegraphy will have in the transmission of the world's intelligence in the very near future.

THE ENGINEER CORPS IN ACTION.

THE ENGINEER IN THE MORO CAMPAIGN.

By an Enlisted Man in the Lake Lanoa Expedition.

We have often urged that the engineer is the one most vitally interested in the results of the opening of new countries. The following short sketch from a participant in the current Moro campaign illustrates the fact that the engineer is also a most active participant in the acts of opening.—THE EDITORS.

ACCOUNTS of experiences of the engineering corps in modern campaigning have been written and re-written relative to the South African war, the Spanish-American war, and the war with the Filipino. But the trials, the achievements, and the general accountings of the engineers in this Moro war appear to me to be quite different from any other experiences. I served with the engineers in Cuba and with the engineers in Luzon, but never encountered tribulations such as these in this Moro campaign. The engineering corps of the army is, of course, one of the important branches so far as the progress of a column of troops in this kind of a country is concerned.

Since the beginning of operations in these southern islands, the United States have attempted to open up the rich island of Mindanao, knowing well the value of the timber lands, the products of rubber trees, and the mineral resources existing in the undeveloped interior. Detachments of soldiers were sent out toward what is known as the lake country, where for generations the Moro tribes have been invin-

cible. Spanish troops were never able to penetrate into the lake sections and remain. They were always driven back with heavy losses by the unruly tribes of Moro fanatics, whose solemn oath is to kill all intruders, believing that if they lose their lives in the attempt, their souls will find peace in the Moro heaven. Detachments of American sol-

"THE CORPS MAN USUALLY HAS HALF-A-DOZEN NATIVES TO DO THE LABORIOUS WORK."

diers were often fired into when they were peacefully surveying the trails and locating positions for stockades or bridge work. On one occasion a cavalry detachment was attacked, one soldier killed and seventeen horses captured by the yelling, fighting natives. Numerous sentries guarding government properties were also shot or cut down in the darkness. Therefore about April 15 of this year it was decided to delay no longer, but to enter the lake regions with a strong force and open the country. The engineers headed the column.

I can give you some idea of the engineering work in the Mindanao expedition by describing the progress of the column to the lakes from Malabang. We had artillery on pack mules, and several pack trains to carry rations and supplies for the troops. We had to go ahead of these trains and cut away the passages. The old trails of the natives were very narrow, and had been washed out to considerable depth, so that if riding in the saddle one had oftentimes either to dismount, or to throw his feet over the horse's neck, to clear the passage. Mud was very deep everywhere. It was climb, push, and hard work for man and beast. The pack mules often caught their packs and had to be unloaded and re-packed. The engineering department went to work

with a will, and with the help of several hundred friendly natives employed at fifty cents per day, and four or five hundred soldiers detailed to fell wood for corduroying the trails, the trails were put into such condition that it was possible to reach the lakes. It was about the latter part of April that we arrived at the lakes.

But the engineer in the campaign of this sort has something more to do than to build trails or erect bridges of lumber cut by the natives (and without nails or metal work of any kind available). He can turn his hand to putting the tentage and general camp into shape for the troops; he can secure gangs of hired natives and details of soldiers with which he soon ditches the camp for drainage, locates the water supply, and arranges for the putting in of a line of bamboo pipes to carry water to various points in the camps; he erects the hospital of bamboo and nipa, cuts a repository in the ground to bury the dynamite, puts up the commissary and quartermaster's shacks for temporary storage of supplies, and by the time the camp is ready to move on to the next position, he has the trails opened up some miles in advance. In fact, it is steady work for the engineers through it all.

ARMED NATIVES OF THE AUXILIARY FORCES.

Our engineer officers customarily went in advance of the head of the column daily, to make inspection for water, good camping positions, easy trails, and the like, often going with but small guard, thereby taking their lives into their hands almost daily. The ground

is full of pitfalls about the lakes, and many a horse and man has fallen into these places. The camping ground must not only be near water, but it must have natural protection. Usually we look for an elevated position, controlling the country about, and then endeavor to find water near it.

This is an odd country, and many of the fixed rules of engineering in the field have to be altered. In this region the head man is the sultan, who govern a district. Under him are dozens of dattos, and each datto rules from fifty to several hundred people. Each datto has his fort or fortified stockade, made in strength according to his power and importance. The sultan's fort is always the largest and best equipped. In our advance during the months of April and part of May of this year, the column encountered very many of these forts, made of bamboo, stone, earth, and other crude material, but exceedingly strong. In a few cases these forts were either deserted or flew the white flag and were not molested. All the others flew the red flag of war and death, and opened fire on us. In most instances these forts were easily conquered, and after the Moros were driven off, the engineering corps would blow up the fort, or one end of it, with dynamite, making a grand exhibition of loose earth, stone, and wood in the air. Pandapatan was our worst fort. We attacked May 2, and before the fight ended one officer and eight enlisted men on our side were shot and killed and four officers and about fifty enlisted men wounded. We could not get into this fort. We planned to blow up one end of the fort during that terrible night, when we lay in the tall wet grass in rifle pits about thirty yards from the fort, and the natives firing into us all the time. We also made scaling ladders of bamboo. We were short of dynamite, but during the next day more came up. However, the natives surrendered on the morning of May 3 and the fight ended.

The engineering corps in the Moro campaign roughs it with the others and there is no "kicking." We carry what we can on our saddles and let it go at that. This means only a shelter half for tentage, and straight rations of food. We get wet in the morning and wet at night, and for thirty days and thirty nights I have been wet constantly, yet not a cold, or illness of any sort, for the climate is mild and even and one can drop down and sleep in wet clothes in safety.

Although engineers, we must soldier. We must be armed and when attacks come use our weapons. Engineers are not supposed to be aggressive. They are supposed to keep on with their work until molested, and then it is time to make fight.

EDITORIAL COMMENT

THE foremost matter in industrial as well as popular interest is "the settlement of the coal strike"—a settlement, by the way, which is of the strike only, and not of a single one of the differences which led up to it. It has taken five months of loss to the operators and miners and outrageous inconvenience and expense to the public, merely to induce the opposing sides to adopt the course which was the only sane one at the outset. It has taken the loss of time, and money, and blood, and life—the sacrifice of industry—the wasteful diversion of productive thought and energy—the unprecedented intervention of the head of the Nation—and finally, the rousing to the danger point of a too patient public opinion—merely to shame these mighty managers of organized capital and organized labor into a sulky adoption of measures which men whose self-magnification has not blinded them to reason would have adopted at the outset.

* * *

The points of contest it is neither needful nor timely to discuss. The best powers of a very able and conscientious commission, exerted through a long period of time, will be none too great for the solution of the primary difficulties between the men and their employers. And the very fact that this was known to and again and again stated by the principals in the fight makes the more inexcusable the reckless determination of each side to impose its own solution by force, at the expense not only of the other side but of the country at large. When dogs fight in the distant field they may perhaps be allowed to fight to a finish, and let their own wounds be their own punishment; but when they fight in the highway, hold up traffic, and make life hideous for the public, they need a sharp reminder that they are a nuisance—in this case the ammonia of public indignation in their nostrils or the hot iron of their owners' punishment to their backs.

Public ownership and operation of the mines is a dream, which would become a nightmare. Legislation may do something, but more negatively than positively—that is, more by withdrawing privileges and protections which enable abuses of position than by attempting a coercion which can be evaded by craft or hoodwinked by wealth or political influence. Compulsory arbitration is a beautiful hypothesis but a practical failure, as New Zealand bears witness. Organization cannot be prohibited without a sacrifice of individual freedom which would entail worse evils than it could prevent. The remedy must come from widespread individual enlightenment and the exercise of the enlightened individual power—by enlightened common-sense. Unless this be exercised, legislation would be a dead letter and arbitration powerless for good. That reason has made sure gain, the past struggle, deplorable as it has been, affords some evidence. Progress is slow, and it needs the comparison of observations made at long intervals to make sure that it is really advancing. But one has only to compare the anthracite

strike with the railroad strikes in Pittsburgh in 1877, the Homestead strike of 1893, or the Chicago strike of 1894, to find progress, in which it must be said that labor, with all its remaining iniquities, shows greater improvement than capital.

* * *

WHEN this wise common-sense is exercised, organization will be not a menace, but the all-efficient safeguard; for presidents, managers, and labor leaders will be controlled by the voice and the votes of the element they dare not neglect to heed—their own stockholders and constituents.

Economy will prevail in the end; the rank and file, both of workers and stockholders, will ultimately see that war is the one condition by which they are sure to lose. The class of leaders who bring on strikes or of managers who cause lockouts will be as finally discredited and retired as the class of rulers who plunge into wars. To doubt it is to deny the plain history not only of industry but of all civilization.

* * *

IN nearly every labor dispute the principal question at issue has been the value which the employee should receive for his time. There is, however, another side of the question, one which does not receive the same consideration, especially from the labor organizations, namely, the value which the employer should receive for his money. In every other kind of a business transaction both sides receive equal consideration, and as a rule the two equivalents are considered in the same kind, one commodity or article of merchandise being exchanged for another, or for its exchange value in circulating medium.

In the case of the employment of labor, however, it is not uncommon to find two articles of an entirely different species being exchanged, so that it is small wonder that difficulties about the exchange equivalent occur. When money is exchanged for time, the return which the man who gives the money gets depends entirely upon the use which is made of the time—a matter which is often entirely lost sight of in the discussion. In this respect the workman has placed himself in an equivocal position, one which, for his own good, he might well hasten to abandon. So soon as he has a definite, concrete thing to sell, and not an indefinite time in which more or less may be produced, just so soon he will place himself in the position of any other business man, and be able to make a bargain dependent entirely upon the value of the goods he has to sell. This position is one which both he and his employer should make haste to welcome, since it removes the fundamental cause of differences of opinion.

* * *

THE complete establishment of definite relations in labor matters involves the abandonment of the one indefinite element in the whole subject, the use of time as a measure of value. The one party should consider the time involved in the production of an article no more than the other; it is the article itself which is the thing. All bugbears about piece work would disappear if the employer paid no attention to the amount which the man was making per day, and thought only of what he paid for the piece. In like manner the workman should be at liberty to use the necessary time in the production of the given article, and make his charge for it by the market value. The only portion of the work in which the time element should enter is that which includes those things which must be measured by time, such as interest, non-productive expense, and general establishment maintenance. These are matters which the employer should

compute independently of the productive labor, and distribute in his costs upon the basis of the time output of the establishment.

When the employee is looked upon in the same light as any other merchant, and the employer as any other customer, then, and not until then, can rational business methods be expected to prevail in the most important department of the world's work.

* * *

THE general interest in technical education, as indicated in leading articles and reviews in this and other issues of this Magazine, is also evident in the growth and extension of institutions devoted to instruction by correspondence. So extensively have these institutions grown that there is no doubt of their widespread influence upon the general methods of technical instruction elsewhere, as well as upon the whole problem of education for modern conditions of life. In this respect these institutions demand consideration in connection with such papers as that contributed by Sir Philip Magnus to this issue of the Magazine, or with those of Professor Dewar, Professor Perry, and Herr von Oechelhauser, reviewed in the following pages.

Apart from the correspondence feature which characterizes these schools, it must be remembered that their work is among a special *clientèle;* but it is altogether possible that some of their methods at least may influence materially the instruction of students who are able to give their entire time to educational matters. The transfer of the management of one of the large schools of correspondence to the Armour Institute, at Chicago, is an indication of the union of interests which has become apparent in this connection, and this fact especially may have an important bearing upon the whole question of technical training.

A characteristic feature of the correspondence schools is the system of text books prepared for the use of the students, and forming integral portions of the courses. These books, excellently printed, illustrated from modern sources, and well bound, contrast remarkably with the ordinary text books used in the schools. Instead of being formal, dry, and repellant, they show the student that he is "into things" from the very start. He sees illustrations of engines, dynamos, machines of all sorts, which really resemble those he sees about him, and finds that the text actually tells him something more than mere generalities about them. Instead of the collection of cuts which look as if they had been taken from the objects in a mechanical museum, he realizes that these are the subjects which he must understand, and that the rules, formulas, tables, and text really tell him how such things are designed and made, and fit him to do it himself.

* * *

ANOTHER most important feature about the correspondence school is found in the fact that the pupils really want to learn. Surprising as this fact may be, it is undoubtedly true that one of the differences between modern technical education and the old-time scholastic method—one which of itself is enough to win commendation for the new system—is that the student no longer has to be driven, pushed, crammed, or punished; he is eager to learn. That this has not always been the case is perhaps the strongest indictment which could be drawn up against the earlier methods.

There are features about the correspondence schools, however, which must be considered in comparing them with other educational institutions. In the first place they are distinctly money-making institutions, their prime

object being the return of profit to the proprietors, and the methods employed for teaching are the outcome of good business sense, just such as might be employed in the preparation and sale of any other commodity. This is evident in the manner in which pupils are sought by canvassers, the country being divided up into districts and subdistricts, and worked as assiduously as is the case with any life-insurance company or any subscription book scheme. There is no real objection to this, if it be understood from the start, since the rule of *caveat emptor* may then be applied in the keenest business sense; but the fact takes the correspondence school entirely out of the category of the great educational institutions, which openly give the student a great deal more than he pays for, and look to endowments, State aid, and other outside resources to make up the deficiency.

Another great defect in the correspondence school is the fact that the personal influence of the teacher is absent. In many instances the privilege of contact with a true, enthusiastic educator is worth far more than all the verbal or written instruction that money can buy. The well-known fact that correspondence papers on technical subjects are frequently examined and corrected by mere clerks, or even by girls, working with a key, is sufficient to emphasize the magnitude of this difference.

There are undoubtedly two sides to the question, and so there is room for both kinds of institutions. The correspondence school will serve well the young man who cannot go to the day school, since it brings a good school to him, and the fact that somebody is making some money out of it is a secondary consideration in such a case. At the same time the influence upon the regular technical school may be most beneficial, in so far as the necessity for constant touch with the outside world in its latest and most practical developments is impressed. The power and scope of the correspondence school may be likened to that of the automatic machine which enables anyone who can pump the bellows to play upon the piano. The great university can be compared to the virtuoso—of incomparably greater power so far as individualization, refinement of expression, and finished technique are concerned, but correspondingly limited in what, for convenience, we might term "volume of performance."

PROBLEMS OF TECHNICAL EDUCATION.

THE DEFECTS OF EXISTING METHODS AND THEIR FAILURE TO MEET PRESENT AND FUTURE REQUIREMENTS.

Notable Addresses in England and Germany.

THE meetings of the British Association for the Advancement of Science are always of interest and importance to the engineer and technical man, not only in the proceedings of the sections especially devoted to engineering science, but also in a broader and more general way. The intimate connection of engineering with all departments of applied science, and the great extent to which engineering questions are becoming matters of everyday life to all people also render the proceedings of the Association of growing popular interest.

A notable evidence of the broadening of the scope of engineering science is seen in the extent to which it is including matters formerly considered to be outside its chosen sphere, and among these latter day questions is the fundamental one of education.

Mediaeval traditions die hard, but when they do die they become very dead indeed. Hence it follows that the efforts to wrest the control and direction of education from the hands of the successors of the schoolmen of the middle ages and transfer it to the guidance of the men who are really doing the work of the world, demand encouragement and publicity, especially when those efforts are made with such power and skill as has been exhibited in England by Perry, Dewar, and others, and on the Continent by Von Oechelhauser, Bach, and their associates.

Professor Dewar, in his presidential address, called attention to the fact that the production of the so-called "exceptional" man is not an expensive process, so far as money cost goes. The total cost of the Royal Institution for salaries and scientific research during the hundred years of its existence has been about £100,000.

During that time it has made possible the investigations of Young, Davy, Faraday, and Tyndall, to which we may add those of Professor Dewar himself, besides others whose labours appear less only by comparison. The Royal Institution has not educated these men, in the ordinary and ancient acceptation of he term, but in the modern and broader meaning of the term, it has been an educational institution of the highest order, one which has enabled these men to develope the capacities which were in them for the advancement of knowledge both for themselves and for the entire world.

Professor Perry, in his brilliant address before the engineering section of the British Association, handles the question without gloves. The absurd idea that mental discipline is best gained by putting artificial difficulties in the way of the student, he brushes aside with a few vigorous words, showing not only the abundance of opportunity for mental discipline in the natural problems which each student must meet and solve for himself, but also emphasising the fact that it is scientific habits of thought and action which it is necessary to produce, and not a mere knowledge of facts which may or may not be of future value, and which in any case may readily be found by reference.

The importance of a proper general edu-

cation for the boy who is to study scientific subjects thereafter, may best be given in Professor Perry's own words:

"What we want to see is that a boy of fifteen shall be fond of reading, shall be able to compute, and shall have some knowledge of natural science; or, to put it in another way, that he shall have had mental training in the study of his own language, in the experimental study of mathematics, and in the methods of the students of natural science. Such a boy is fit to begin any ordinary profession, and whether he is to enter the church, or take up medicine or surgery, or become a soldier, every boy ought to have this kind of a training."

The most interesting thing about the whole question is that there is in progress a general awakening to the fact that men are living in a new world, a world which is as certain to make new methods and standards for itself as did the ancient and the mediaeval worlds. The men who are doing things, the men who are controlling things, who are mastering the lives of nations and dictating to their governments, these are the men by whom the methods of education are to be directed. Education, both general and technical, can no longer be held in the grasp of the dead hand; indeed the stiffened fingers are already well loosened, and life and vigor is being infused on all sides.

The situation in Germany is also interesting as regards educational matters. In England Germany is constantly quoted as a land in which technical education is maintained at a high and modern level. The presidential address of Herr von Oechelhaüser before the Verein deutscher Ingenieure, however, shows that there is room for much discussion. Commenting upon the new responsibilities which rest upon the technical educational institutions of Germany with the authority to grant degrees in engineering, bestowed by the Emperor last year, he calls attention to the necessity for the infusion of living thought and action into engineering education. Specialisation must not be permitted to stifle a broad grasp of the conduct of life and the control of men and things. Professor Bach has well shown that there are two distinct kinds of material required for the production of industrial wealth, the dead and the living. The student may be well instructed in the art of using the dead materials of which engineering products are composed, but unless he knows how to use the living material, the men by whom the work is to be done, his training is most incomplete.

All this but emphasises the fact that technical education can no longer be considered as a thing apart from education in its broader sense, it is to become the controlling element in educational work in all lands. The engineer is no longer a mere mechanic, a kind of specialised tradesman. He has become the exploiter of the world in the highest sense, at the same time constructor, economist, financier, statesman; and the education which is to fit men for such functions must be the broadest and best the brain and experience of man can devise. Mere precedents will not do in such a task. To know "what has been done, and who did it" is all right, but often merely as a means of knowing what to avoid in the future; while to know "what to do, and how to do it" must be the basis of all education in the future, not only technical but general, in the broadest sense of the term.

ELECTRIC LIGHTING FOR RAILWAY TRAINS.

STEAM-TURBINE DRIVING FOR LIGHTING DYNAMOS ON EXPRESS TRAINS OF THE PRUSSIAN STATE RAILWAYS.

Oberbaurath Wichert—Verein Deutscher Maschinen Ingenieure.

THE use of independent engines and dynamos upon the locomotives of railway trains for the purpose of furnishing the current for lighting the carriages has been held to possess conspicuous advantages and disadvantages. Any other system requires the installation of a greater or less number of storage battery cells, and the ability to dispense with these is certainly to be welcomed.

At the same time the dependence upon mechanism attached to the locomotive, renders the train helpless, so far as current is concerned when the engine is detached.

Another, and most important objection to the independent plant is found in the general low economy of small steam engines, such engines requiring from 80 to 120 pounds of water per horse-power-hour, even when in good order.

The first objection to the independent electrical plant does not apply to long-distance express trains, making runs of 100 to 250 miles without stop, since the locomotive carrying the engine and dynamo is not detached at any time when light is required in the train. The second objection, that of excessive steam consumption, is now sought to be overcome by the employment of the steam turbine as a motor, the economy of these machines being nearly as good for small powers as for larger machines.

The various systems of electric train lighting which involve the use of a separate generator on each carriage, driven from the axle, and used in connection with a small storage battery, are by no means so simple as at first appears. As discussed in the paper of M. Guérin, in the last issue of this Magazine, special provision has to be made for the variations in the speed of the train and for the possible reversal in the direction of rotation of the dynamo, and none of the plans yet proposed has been altogether satisfactory.

At present the best results have been obtained by the use of the engine and generator mounted on the locomotive and taking its steam from the main boiler; together with a moderate equipment of storage battery in each car for the maintenance of the current during the brief periods when the locomotive may be disconnected.

In a paper recently presented before the Verein deutscher Maschinen-Ingenieure by Herr Oberbaurath Wichert, and published in *Glasers Annalen*, some account is given of the equipment of the trains of the Prussian State Railways, in which the De Laval steam turbine is used as the motive power in the independent generating plant mounted on the locomotive.

The general arrangement of the apparatus is simple. The turbine, of 20 horse power, running at 20,000 revolutions, geared down to 2,000, is attached to the same base plate as the dynamo, the whole being mounted on the top of the boiler of the locomotive, with handles operating the valves extending back into the cab of the engine, placing the entire control in the hands of the locomotive engineer.

A continuous current generator is used, operating at a pressure of 68 volts, and giving a current of 180 amperes. In connection with the generating machinery there is a storage battery of 32 cells in each car, this being capable of supplying light for about 3¼ hours in case of interruption with the generator.

The paper discusses at length the system of wiring adopted for the corridor compartment trains used on the express trains, together with the arrangement of the regulating resistances by means of which the current is maintained uniform for the varying demands.

Experiments have been made upon trains running from Stettin to Stralsund—Sassnitz, and also between Berlin and Altona, with satisfactory results, and upon these records Herr Wichert deduces some general information concerning this system of train lighting.

There is no doubt that electric lighting is by far the best for use on railway trains so far as convenience and satisfactory illumination is concerned. The brilliancy of the light is unsurpassed, the lamps can be placed in the most convenient locations for reading and for freedom from the production of dense shadows, while the general control of the illumination which can be given to the lighting of the whole train is an important feature. The air of the compartments is not vitiated, the influence of draughts of air, so important in connection with oil and gas lighting, becomes negligible. In view of these facts it is evident that only questions of cost can be opposed to the general installation of electric train lighting.

According to Herr Wichert's figures the cost of electric lighting over the use of oil gas, such as is employed in the Pintsch system for example, is about threefold. This, however, varies somewhat according to the duration of the lighting period, the cost of lighting by gas increasing much more rapidly with the increase in time than is the case with electric lighting.

While it is not to be expected that the manifest advantages of electric lighting can be obtained at the lower cost of inferior sys-

tems of illumination, yet it may be practicable to reduce the cost somewhat. Thus the steam turbines referred to by Herr Wichert were by no means so economical as they might have been, the steam consumption reaching 19 to 20 kilogrammes per horse-power-hour (about 42 to 45 pounds), but there is no reason why the steam consumption should not be about one-half this amount, judging by the recent results which have been obtained with turbines of the same construction elsewhere.

PRACTICAL CREMATION OF GARBAGE.

A CRITICAL EXAMINATION OF THE PERFORMANCE OF THE REFUSE-DESTRUCTION PLANT AT TRENTON.

Report of Mr. Rudolph Hering.

IT is now generally conceded that the proper way to dispose of garbage and house refuse is by cremation, but it is not always fully understood that a refuse destruction plant, to be fully satisfactory, should be designed and operated with the skill of the trained engineer. It is some time thought that garbage can be burned just like any other material, and the only requirements in furnace design involved are those relating to capacity and handling of material. The fallacy of such views is clearly shown in the very interesting report recently made by Mr. Rudolph Hering upon the destructor plant at Trenton, New Jersey, where the unsatisfactory performance of the installation rendered it necessary to give the matter skilled attention.

That garbage can be effectively and inoffensively burned cannot be denied, since this operation is daily carried on in various cities. Furthermore, the heat produced by the combustion of the organic matter has in numerous instances been utilized for the generation of steam to an extent which practically meets the expenses of operation of the plant. When, therefore, a disposal plant is both offensive and expensive, it is evident that the best results of engineering experience have not been secured, and that the defects must be in the execution of the idea, and not in the idea itself.

The first, and most important function of a garbage destructor is that it shall consume all the organic matter fed into it so fully and completely that there shall be no offensive odors emitted, and that no unburned particles shall escape from the furnaces. These points being completely assured, the utilization of the heat may be considered, together with the economy in fuel required for the operation of the plant. Without going into the details of the plant at Trenton, it will suffice to explain its general arrangement. The garbage is first delivered into drying chambers, where the moisture is partly drained off, after which it is raked into a combustion chamber, in which coal is burned on the grate to assist in the combustion of the organic matter. The liquid from the drying chamber is collected in an evaporating pan, and the gases evolved in the combustion chamber are passed through a flue and over auxiliary coal fires for the purpose of eliminating any odors which might otherwise remain. The ashes produced by the burned refuse are raked out by hand, when, in the judgment of the attendant the combustion is completed.

The practical working of this apparatus is about what might have been expected. The emitted gases are not free from odors, unburned particles escape up the chimney and are carried over the neighborhood together with an appreciable amount of dust, while sufficient unconsumed garbage is removed with the ashes to cause offensive odors to be produced.

To an engineer the causes of these defects appear due to obvious causes. Incomplete combustion is caused by attempts to cremate the refuse too rapidly and at too low a temperature. The carrying of dust and particles of garbage out of the chimney point to a high rate of speed of the gases through the flues, while unburned garbage in the ash is a natural consequence of the attempt to maintain a high rate of combustion in connection with unskilled attendance at the furnaces.

The long experience which has been gained in England with refuse destruction,

supplemented by the scientific tests made upon plants recently erected in various parts of Germany, shows that a high temperature is necessary in order to effect complete incineration, and that sufficient time must be given to insure the entire combustion of all the organic matter. To this end the drying chamber is arranged with inclined grates, so as to deliver the material gradually to the combustion cells, while in these latter a very high heat is maintained, chiefly by means of a forced blast. By such means a complete combustion of all organic matter can be secured, if the incineration is conducted slowly enough, while the resulting clinker is altogether inorganic and odorless, and in some instances possesses a market value for cement making or for road material.

The question of the interception of dust and light material from escape by the chimney, is simply a matter of reduced velocity, easily obtained by increased cross section. This means that a properly proportioned dust chamber, with suitably arranged baffle walls, should form a feature in every refuse destructor, and if to this is added an auxiliary grate for final decomposition of the gases, the essentials of satisfactory operation are obtained.

The use of coal as an aid to the combustion of the refuse may be necessary when the material is low in combustible, or when much moisture is present. If the drying chamber is properly arranged, however, the excess moisture may be largely removed before the refuse is fed into the incinerating cell, and when the material contains unsifted ashes, it is quite practicable to complete the incineration without the use of fresh coal. This, however, is a minor question, since it is not so much high economy as complete and inoffensive cremation which is demanded. If a steam generating plant forms a portion of the installation the heat produced by the combustion of fresh coal is partially recovered, and hence it is altogether possible that in cases where the garbage is low in combustible material the design should include a steam raising plant and additional fuel consumption as an element of economy.

The most important features of the whole subject appear in the evident necessity for the use of a high degree of engineering skill in the original design of a destructor plant, together with the employment of skilled firemen in its operation. To assume that a form of destructor which has operated well in one situation will necessarily do well in another, is altogether unwarranted. Each location should be examined on its merits, all the conditions being considered for a period sufficiently long to enable not only average, but exceptional features to be determined. The plant should be designed by engineers familiar with the principles of combustion and the requirements of the situation, and it should be operated by trained firemen and not by ignorant laborers.

There is no difficulty whatever in the complete and satisfactory cremation of refuse within city limits in a manner altogether inoffensive and frequently profitable, but the work must be done by engineers and not by politicians or ordinary mechanics.

MILITARY AUTOMOBILES.

THE GREAT DESIRABILITY OF A SUITABLE INTERNAL-COMBUSTION MOTOR FOR SELF-PROPELLED MILITARY VEHICLES.

Report of the War Office Committee.

LAST February the motor trials made before the War Office Committee in the course of its investigations upon the suitability of automobile vehicles for military service were reviewed at length in these columns from unofficial reports in various technical journals. Now we have the official report of these same trials, and find it a most interesting document in view of the recommendations contained therein, these, of course, being lacking in any previous discussion.

It will be remembered that the requirements limited the trials to vehicles capable of hauling loads of 5 tons net, of which 3 tons was to be carried on the lorry itself, and 2 tons on a trailer, the fuel and water being additional. But five vehicles actually took part in the trials, four of these being propelled by steam, and one only by an in-

ternal-combustion motor, this latter being entered by Milnes & Co., and equipped with a Daimler motor. Although all the various vehicles were installed at one time or another during the trials, this was only to be expected in view of the difficult ground and the severity of the tests. Since it was the intention of the committee to find out just which conditions were likely to interfere with the working of motor lorries in cross-country work the trials were arranged with that end in view.

The final report, some extracts from which are appended, brings out some interesting features. In the first place, although the steam vehicles did the best work in the trials, it is seen that the internal combustion motor appealed to the military experience of the judges very strongly, the independence of water supply, and the high fuel economy, being considered most valuable points. At the same time the use of highly inflammable fuels, such as gasoline, or petrol, is held to be out of the question, and heavy oil alone can be considered. This conclusion may lead to the development of an engine along the lines of the Diesel motor, since we understand that Herr Diesel has already equipped an automobile with his motor, and its capability of burning anything in the line of heavy liquid fuel should render it especially suitable for the exigencies of military service.

Another most important point in the report is the emphasis which it lays upon the demonstration of the fact that the existing road regulations are unnecessary for properly constructed vehicles. This may have a most important influence upon the general design of motor lorries for all kinds of service, and is most encouraging.

The following extracts from the official report will be of interest:

"The trials have shown that these steam lorries are good and serviceable machines suitable for present supply, and likely to be of good advantage to the transport service in countries where fuel and water in sufficient quantity is available. The committee, however, desire to call attention to the great possibilities for military purposes of the internal combustion lorry burning heavy oil, as shown by the small fuel consumption and practical independence of water of the one which was tried, belonging to George F. Milnes and Company, Limited. The committee strongly recommends that steps to develop such lorries be proceeded with.

"Compared with horse-draught, these trials have shown that self-propelled lorries can transport five tons of stores at about six miles an hour over very considerable distances on hilly, average English roads under winter conditions. The load transported by each single lorry (five tons), if carried in horse-wagons of service pattern would overload three G. S. wagons, requiring twelve draught horses, besides riding horses, whose pace would not ordinarily exceed three miles an hour. Moreover, the marching of 197 miles in six consecutive days over hilly roads would not have been accomplished by horses even at that speed without the assistance of spare horses.

"The committee are of opinion that it has been demonstrated that mechanical transport of this nature has many advantages, and that it is well worth a much more extended trial.

"Regarding the type of lorry, the experience gained at these trials has caused the committee to somewhat modify their original views. On more than one occasion the disadvantage of the trailer in preventing the lorry from moving freely backwards when required was clearly noticeable. On the whole the committee consider that a lorry drawing a single wagon, while having the disadvantages accruing from the use of a trailer, does not obtain, owing to there being only one of these vehicles, the full advantages which should belong to the system, and they consider that for handy and rapid work of distribution among troops and near the front of an army a lorry without trailer is preferable. At the same time they consider that for the heavier work of moving stores in large quantities to the depots a powerful tractor, drawing a train of wagons behind it will be found most suitable.

"The committee therefore recommend that they be empowered to take steps to obtain for trial a lorry or lorries on the following lines:

"To carry three tons, driven by an internal combustion engine burning heavy oil only; weight as light as consistent with due adhesion; wheels large and broad, and fitted with a means for rapidly applying nu-

merous 'spuds' for use on boggy ground. Speed up to eight miles an hour; large platform area.

"Finally, the committee beg to call special attention to the demonstration afforded by these trials of the entire harmlessness to roads of vehicles considerably exceeding in weight and road-speed the limits allowed by the present regulations on the subject, and also fitted with wheels to which road strips have been fixed, so long as these wheels are of large diameter and have tyres of considerable width. It has now been proved that the existing regulations are unnecessarily restrictive, whilst they stand in the way of the development of a most important method of transport and branch of industry.

"The committee strongly recommend that this matter be brought to the notice of the proper authorities, feeling confident that the removal of these restrictions will tend to assimilate the commercial and military types of vehicles, and is not only important therefore from a service point of view, but also will have a most beneficial effect on the manufacturing industries of the country and its commercial development generally."

THE SAULT SAINTE MARIE POWER PLANT.

THE COMPLETION OF THE GREAT HYDRAULIC POWER PLANT AT THE OUTLET OF LAKE SUPERIOR.

H. Von Schon, in Engineering News.

IT has frequently been assumed that cheap power is a controlling element in the location of manufacturing establishments, but it is by no means so important as to outweigh other considerations. When, however, we take into account the electro-chemical industries of recent development, the cost of power is found to be so essential a feature as to render it the principal element in the selection of a site.

This fact has doubtless done much to aid in the development of the important hydraulic power plant at the Sault Sainte Marie, the well-known rapids at the outlet of Lake Superior, since the situation is otherwise too remote from manufacturing centres to render it desirable for general industries.

The Sault Sainte Marie is the name given to the rapids of the St. Mary's river, a sandstone ledge in the river producing a fall of about 20 feet in a length of about half-a-mile. The fall is thus only moderate, but the large volume of water discharged, varying between 3,600,000 to 7,000,000 cubic feet per minute, renders the location well adapted for the utilization of a large power. On each side of the rapids there are already canals for the accommodation of the lake navigation, and it is well known that through these canals there passes, during the season of navigation, the largest tonnage traffic of any body of water in the world.

Naturally this large water-power has attracted attention of hydraulic engineers for a long time, since it required only the cutting of a comparatively short canal to render about 50,000 horse power available. It was not until about four years ago, however, that the progress of the appropriate manufacturing industries rendered the construction of a power plant advisable, and it was in 1898 that the work was actually commenced.

From an account of the completed work by Mr. H. von Schon, the engineer who has carried the works to a successful termination, published in a recent issue of *Engineering News*, we review here briefly the salient features of this important undertaking. The total length of the canal is about 10,000 feet, cut partly through sand, and gravel and partly through sandstone. Portions of the channel are therefore confined by walls of masonry resting on timber crib-work, while the remainder has vertical sides cut through the rock. In order to insure a smooth and permanent channel, the sections of the canal passing through sand and clay have been lined with timber planking, not only on the sides but also on the bottom, this lining connecting with the surfaces of the stone portion of the channel. This construction secures a perfectly smooth section throughout the whole canal, materially decreasing the resistance to the flow of the water, a matter of considerable importance with so long a

canal having so low a head of water for utilization. This uniformity of cross section is important, not only for the reduction of surface friction, but also for the diminution of eddies and swirls in the water, it now being well recognized that the losses due to the internal work of the water caused by undulations and irregularities in the bed form a large proportion of the resistance to the water flow in a canal.

The cross section of the canal below the water line is 4,800 square feet in the intake, 4,600 feet in the rock channel, and 4,300 feet in the timber-lined sections. With the power house running at its full capacity the velocity of flow will be about 4½ miles per hour, delivering approximately 30,000 cubic feet of water per second, and enabling the turbines to develope about 60,000 horse power.

In order that the flow of water through the canal shall not alter the level of the water in Lake Superior, the government has required the company to construct compensating works in the St. Mary's river. These works include a dam, extending 2,000 feet out from the Canadian shore, this dam containing four Stoney sluice gates by which the outlet for water may be regulated according to the season.

The power house, which is placed in a forebay closing the outlet of the canal into the St. Mary's river below the rapids, contains eighty-one chambers of concrete, each equipped with one generating unit. Each hydraulic unit consists of four 33 inch turbines arranged in two pairs on one horizontal shaft, the shaft passing through a steel plate bulkhead into the generator room, and the electric generator being carried upon the prolongation of the turbine shaft. Each hydraulic unit is designed to use 391 cubic feet of water per second, at an effective head of 16 feet, developing 568 horse power and driving a dynamo of 400 kilowatts capacity.

The total cost of this important work approximates about four millions of dollars, and it has required about four years in its execution.

As already indicated, the application of the 50,000 to 60,000 horse power thus derived from the water of Lake Superior must be found in the development of new industries, drawn to the site by the advantage of cheap power. The experience of the great hydraulic plant at Niagara Falls has shown that much more is to be expected from electro-chemical industries than from any existing lines of work. In fact the existence of abundant water power has done much to render possible on a commercial scale operations already well known in the laboratory, but previously impracticable from a business standpoint. Now that calcium carbide, carborundum, graphite, aluminum, caustic alkalies, nitric acid, etc., etc., are directly produced by the electric current there is no need to induce manufacturing industries involving a proportionally small amount of power to migrate to the "Soo." Doubtless a new settlement will spring up, as there has at Niagara, another example of the fact that facilities create business as well as traffic.

TECHNICAL APPLICATIONS OF ALCOHOL.

ITS USES AS A SOURCE OF HEAT, LIGHT, AND MOTIVE POWER, BASED UPON RECENT DEVELOPMENTS IN FRANCE.

Society for the Encouragement of National Industry.

IN view of the importance of providing an outlet for the large production of alcohol in the arts there have been various attempts made of late in France to develope industrial applications of the product, several exhibitions having been made of apparatus devised for this purpose. In order to place the subject before the industrial and commercial world in a scientific and authoritative light the matter has been taken up by the Société d'Encouragement pour l'Industrie Nationale, and the reports of MM. Lindet and Ringelmann, members of the Council, to the society appear in a recent issue of its *Bulletin*.

It is understood, doubtless, that the principal element in the price of alcohol appears in the tax which is placed upon it in most countries. When, however, by means of an admixture of gasoline, benzine, or

some similar ingredient it is made wholly unfit for human consumption, this element of cost may be removed, and from its high calorific power alcohol may take an important position as an industrial combustible.

So far as use as an illuminant is concerned, alcohol requires the employment of some form of incandescent mantle, in order that the heat may be converted efficiently into light. A variety of such lamps has been made, the principal forms including a reservoir for the alcohol, a wick to produce a suitable flame, and such an arrangement of chimney draught as to give a combustion intense enough to raise the mantle to full incandescence. In one form a metallic thimble is placed above the wick to retain sufficient heat to aid in vaporising the fuel before burning, but such devices do not appear to be generally necessary. Some lamps have been made to burn a highly carburetted alcohol, with the intention of supplying sufficient incandescent carbon to avoid the necessity for use of a mantle, but these are adapted for moderate lights only.

A more important class of lamps includes those of higher power, suitable for street and public lighting in situations where illuminating gas is not available. They operate by the gasification of the alcohol, either by derivation of a portion of the flame, or by a regenerative device in connection with the main burner, the alcohol being supplied under pressure, and the intense heat thus produced being employed upon one or more incandescent mantles. Such lamps offer numerous advantages for situations where gas or electric distribution is not available, the light being much more intense than that of ordinary gas burners.

The report of M. Lindet contains full tabulated data and results of tests of fuel-consumption and illuminating power of the various lamps. The luminous power varies greatly with the extent to which the alcohol is mixed with other hydrocarbons, with the pressure employed, and with the size of the lamp, the large lamps consuming less than one cubic centimetre per candle-power-hour, while for the small lamps the consumption in some instances rose to more than four cubic centimetres.

The use of alcohol in internal-combustion motors is a matter of much interest, since the increasing use of such machines for the propulsion of automobiles, launches, etc., offers a wide field for the disposal of a large part of the product.

Numerous trials were made upon motors, independently of the applications to which they may be put, each trial being made with two kinds of fuel, pure methylated alcohol, and alcohol carburetted 50 per cent. These tests confirmed the results made in the trials in 1901, namely that under the same conditions of operation, the consumption of alcohol carburetted 50 per cent. is 0.7 that of pure alcohol, this holding good for six different motors developing from 5 to 35 horse power. The principal feature demanding attention in motors to use alcohol fuel is the carburetter, this requiring careful adjustment to supply the proper proportion of carburetted air to the motor to secure the best results. The lowest fuel consumptions were obtained with the motors operated at moderate rotative speeds, the economy diminishing with increase in speed, this probably being due to the time required for complete combustion.

Doubtless this result could be modified by using an increased degree of compression, and there is every reason to believe that with motors especially designed and proportioned for use with alcohol fuel, in the light of the recent experiments, good economy at high speeds could be secured.

Certain tests were made upon automobiles using alcohol fuel, the machines being placed upon dynamometer brakes to supply the measured resistance, the tractive power being measured by receiving the pull upon a spring balance. With a speed corresponding to 16 kilometres per hour, exerting 3.69 horse power, the consumption was 1.73 kilogrammes, while for a speed of 29 kilometres, and a development of 4.93 horse power, the consumption rose to 3.03 kilogrammes. Experiments with boats on the Seine confirmed these results, the consumption increasing with the speed.

There appears to be little doubt that the several applications of alcohol for the production of light, heat and power have been demonstrated as to practicability to an extent sufficient to warrant the assertion that any reasonable output will find a satisfactory market.

PROGRESS OF THE NEW TECHNICAL DICTIONARY.

PROVISIONAL REPORT OF THE EDITOR OF THE "TECHNOLEXICON," THE NEW FRENCH-GERMAN-ENGLISH TECHNICAL DICTIONARY.

Dr. Hubert Jansen—Verein Deutscher Ingenieure.

SEVERAL years ago it was suggested in these columns that the defects in existing technical dictionaries demanded the production of a new and improved work, and it was then proposed that the various technical and professional societies in England, France, Germany and the United States should take up this work. Shortly afterwards the Verein deutscher Ingenieure announced its intention of preparing a dictionary of technical and mechanical terms in English, French, and German, and called upon the professional societies of other countries to lend whatever aid might be available, so far as the preparation of the copy was concerned. The German society proposed to bear all the financial responsibility itself, and it has well borne out this idea, having appointed Dr. Hubert Jansen as Editor-in-Chief and pushing the work forward continually.

At the recent meeting of the Verein deutscher Ingenieure at Düsseldorf, Dr. Jansen made a progress report, from which we make some abstracts, giving an idea of the magnitude and extent of this most important work, as well as the efforts which are being made to carry it through.

Thanks to the energetic efforts of the management, there are now interested in the work, according to the record at the close of June, 1902, 316 technical societies, of which 266 are in Germany, 25 in England and America, and 25 in France. There are also 1,754 independent collaborators at work, 1,333 in Germany, 229 in England and America, and 192 in France. Various circulars, note books, and instructions have been sent out, and the work has been prosecuted in a most systematic manner from the start. Dr. Jansen estimates that the collection of the material will be accomplished by the close of 1904, and that the final revision and publication will bring the completion of the work to the close of the year 1906.

From the provisional account of the work, as given by Dr. Jansen in his report, some interesting notes may be given. In the first place the work is a dictionary, not a technical encyclopaedia. Its primary service is to be an aid to translation, and this limit must be kept in mind in criticising the work. Three volumes are to be issued: German, French, English; French, German, English; and English, German, French; the name "Technolexicon" having been chosen for the whole work. Especial attention has been given to the compilation of words from trade catalogues and lists, while the attempt has been made to secure all existing technical dictionaries in the respective languages for comparison and reference. This portion of the work is still in progress, and the contribution of trade catalogues, even if in but one of the three languages under consideration, is solicited by the editor.

In order that some general idea of the nature of the work may be obtained, Dr. Jansen gives some examples, showing the method of arrangement and classification which has been adopted.

As a rule the attempt will be to give the correct equivalent words or expressions translating the technical terms of each one of the languages into the two others. Definitions, explanations and sketches will be given only when absolutely imperative, this being especially the case of dialetical, rare, obsolete, quite new or little known expressions. Usually it is considered that a statement of the thing, machine, or operation of which the word under consideration forms a part, will be sufficient to determine its identity beyond doubt. This treatment of the work is being greatly facilitated by the preliminary preparation of lists of words belonging to the various trades, professions, and industries, so that the usage of a word determines its classification.

Although it is altogether too soon to make any criticism of the work, especially as criticism of an unfinished undertaking is apt to be unsatisfactory, it may be permitted to call attention to some points in connection with the examples which Dr. Jansen submitted in his report.

Thus the translation of the German

"steigung" or "ganghöhe," referring to screw threads, is, in English properly "pitch," this being much more used than "lead." The limitation of "pitch" to the number of threads per inch, does not agree with the best practice, "pitch" distinctly meaning the distance from one thread to the next turn of the same thread. This will be seen when double or triple-thread screws are considered, the number of threads counted per inch being distinctly not the pitch.

Again the translation of the word "schablone" by "standard" in the sense of standardized work, is hardly the best that could be made. Strictly speaking "schablone" means a "template," the device by means of which manifold standardized and interchangeable parts are made, but the better equivalent for the English word "standard" is the term "normalien" already in extensive use in connection with electrical and mechanical reference standards.

Instead of the term "bessemering" it is more general in English to use the word "bessemerising." These, and a few other expressions which might be noticed show that in the final revision of the work a careful editing should be given by competent specialist editors of the nationality of each of the three languages, and doubtless this will be done.

In this connection attention may be directed to the differences which exist in shop terms in England and in America, the same things being called by different names. The use of belt for strap, of Moncky wrench for screw key, etc., will serve as examples which might be included.

The whole work is of such importance that this progress report is most welcome, and it is to be hoped that the general call which has been issued for manufacturers' catalogues, lists of words, titles of dictionaries and vocabularies, etc., etc., will meet with prompt and numerous responses from engineers and manufacturers all over the world.

THE PRODUCTION OF LOW TEMPERATURES.

HOW THE ABSOLUTE ZERO IS BEING CLOSELY APPROACHED IN THE LIQUEFACTION OF HYDROGEN AND HELIUM.

Presidential Address of Professor Dewar.

AMONG the scientific researches of recent times there are few of greater interest than those connected with the production of extremely low temperatures, including the effects which such conditions produce upon well known substances. The results of recent investigations have been recorded from time to time in the pages of the technical and scientific papers, and now we have, in the presidential address before the Belfast meeting of the British Association for the Advancement of Science, a summary of the present state of information upon this fascinating subject from the lips of Professor Dewar, who himself, has been one of the ablest and most successful workers in this field.

The production of low temperatures by artificial means resembles in one respect that other frigid problem, the search for the North Pole in that it has an ultimate goal before the investigator, to reach which is to achieve world-wide fame. According to the theory of the expansion of gases, confirmed by the investigations of Kelvin upon the relations of heat and work, a gas contracts 1/273 part of its volume for a reduction of one degree centigrade in temperature. From this results the determination of the so-called absolute zero at a point 273 dgrees below the common zero or melting point of ice, and it is to the attainment of the absolute zero and a study of the behaviour of various forms of matter at that temperature that much study and effort has been directed.

Professor Dewar reviews rapidly the work of early experimenters in this field, calling attention to the little known work of Amontons at the beginning of the eighteenth century, and coming down to the modern period, after the production and properties of liquid carbonic acid became known. By the use of this agent Faraday succeeded in producing temperatures as low as 110°C., and by combining this low temperature with pressure all the gases were liquefied by the close of 1844 with the ex-

ception of the three elementary gases, hydrogen, nitrogen, and oxygen, and three compound gases carbonic oxide, marsh gas, and nitric oxide.

Further progress in the reduction of temperature was impeded by the difficulties in connection with the protection of the cooled substances from the external heat. As Professor Dewar well puts it the production of liquid air in the atmosphere of an ordinary laboratory is a feat analagous to the production of liquid water starting from steam at a white heat, and working with all the implements and surroundings at the same high temperature. The problem was not so much how to produce intense cold as how to save it when produced from being immediately levelled up by the relatively superheated surroundings. This portion of the problem was solved by Professor Dewar himself by keeping the liquefied gases in vessels having double walls, the annular space between being very highly exhausted. By coating the inner walls with a bright deposit of silver the influx of heat was still further reduced, and thus the ingoing heat was brought down to about 3 per cent. of what it would otherwise have been.

The application, by Linde, of the so-called counter-current apparatus, uniting the cooling action of an expanding gas with mechanical compression, made the production of liquid air possible, and using this as a fresh refrigerating agent, furnished material for attack of the problem of the liquefaction of hydrogen. This feat was accomplished by Dewar himself in 1898, and the product, as described by him, is a most interesting substance.

"Liquid hydrogen is a colorless transparent body of extraordinary intrinsic interest. It has a clearly defined surface, is easily seen, drops well, in spite of the fact that its surface tension is only the thirty fifth part of that of water, or about one-fifth that of liquid air, and can be poured easily from vessel to vessel. The liquid does not conduct electricity, and, if anything, is slightly diamagnetic. Compared with an equal volume of liquid air, it requires only one-fifth the quantity of heat for vaporisation; on the other hand, its specific heat is ten times that of liquid air or five times that of water. The coefficient of expansion of the fluid is remarkable, being about ten times that of gas; it is by far the lightest liquid known to exist, its density being only one-fourteenth that of water; the lightest liquid previously known was liquid marsh gas, which is six times heavier. The only solid which has so small density as to float upon its surface is a piece of pith wood. It is by far the coolest liquid known. At ordinary atmospheric pressure it boils at minus 252.5 deg., or 20.5 deg. absolute. The critical point of the liquid is about 29 deg. absolute, and the critical pressure not more than fifteen atmospheres. The vapour of the hydrogen arising from the liquid has nearly the density of air—that is, it is fourteen times that of the gas at the ordinary temperature. Reduction of the pressure by an air pump brings down the temperature to minus 258 deg., when the liquid becomes a solid resembling frozen foam, and this by further exhaustion is cooled to minus 260 deg., or 13 deg. absolute, which is the lowest steady temperature that has been reached. The solid may also be got in the form of a clear transparent ice, melting at about 15 deg. absolute, under a pressure of 55 mm., possessing the unique density of one-eleventh that of water. Such cold involves the solidification of every gaseous substance but one that is at present definitely known to the chemist, and so liquid hydrogen introduces the investigator to a world of solid bodies."

The next step towards the absolute zero is to find another gas more volatile than hydrogen, and this occurs with helium. While this has not yet been liquefied it may be so, provided its critical point is not below 8 degrees absolute. If a sufficiently low temperature cannot be reached by the use of liquid hydrogen, it may be attained by the mechanical production of cold by the performance of external work. In any event it is probable that there exist gases other than helium of greater volatility than hydrogen; and it is extremely improbable that the absolute zero will ever be reached by man.

It may be asked, of what use is all this striving to attain low temperatures? but such a question might have been asked of many lines of scientific research which have developed ultimately beyond all conceivable expectations. The researches of Faraday in electricity and magnetism never passed

beyond the laboratory stage in his hands, yet upon them is based the whole of modern commercial electrical engineering, and similar comparisons might be made in nearly every department of applied science.

There need never be any fear that the domain of science will become exhausted, or that the limits of Nature will be reached.

"The battlefields of science are the centres of a perpetual warfare, in which there is no hope of final victory, although partial conquest is ever triumphantly encouraging the continuance of the disciplined and strenuous attack on the seemingly impregnable fortress of Nature. To serve in the scientific army, to have shown some initiative, and to be rewarded by the consciousness that in the eyes of his comrades he bears the accredited accolade of successful endeavour, is enough to satisfy the legitimate ambition of every earnest student of Nature. The real warranty that the march of progress in the future will be as glorious as in the past lies in the perpetual reinforcement of the scientific ranks by recruits animated by such a spirit, and proud to obtain such a reward."

ALLOYS OF ALUMINUM.

APPLICATIONS OF METHODS OF METALLOGRAPHY TO THE STUDY OF ALLOYS OF ALUMINUM WITH OTHER METALS OF CONSTRUCTION.

M. Leon Guillet in Bulletin de la Société d'Encouragement.

AFTER the development of the electrical methods of isolating metallic aluminum, about ten years ago, much was said about the uses of the metal in the arts, its principal property of value being thought to be its low specific gravity. It soon appeared that this was of less importance than had been at first considered, the fact being that, weight for weight, aluminum is about equivalent to steel, being about one-third the specific gravity and also about one-third the tensile strength. Nevertheless aluminum has found an important place among the materials of the engineer, mainly in connection with other metals, the properties which it imparts to alloys rendering it extremely useful.

With the development of the methods of metallography, in which the structural constitution of metals and metallic alloys is examined by the microscope upon polished and etched sections, much has been done to advance to employment of special alloys. The critical study of the alloys of aluminum, contributed to the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, by M. Leon Guillet, contains much information of interest upon this subject.

M. Guillet also gives some valuable details concerning the Goldschmidt process of obtaining very high temperatures by the combustion of metallic aluminum, his paper forming on the whole a discussion of the general industrial properties of the metal.

Taking advantage of the high temperature produced by the combustion of metallic aluminum, M. Guillet has employed it to effect at one and the same time the reduction of the special metal which he desired to alloy with the aluminum and to make the alloy, the result being the production of a number of alloys not generally used. These he has then examined by the processes of metallography, and he results form a complete record of the available alloy of the series.

M. Guillet describes in details the methods which he employed, these briefly consisting of the preparation of the oxide of the metal to be alloyed with the aluminum, in a fine powder, mixing it with the aluminum, the latter usually being in fine grains, thoroughly washed with ether to remove any traces of grease. This mixture was packed in a crucible and ignited by a fuse consisting of a mixture of aluminum powder and binoxide of barium, touched off by a match. After the fused mass had cooled, the crucible was broken and a metallic mass was found, usually enveloped in crystals of corundum. This mass consisted of an alloy of the metal reduced from its oxide, with a portion of the aluminum of the charge, and this was then polished, etched, and its constitution and composition studied.

In his original paper M. Guillet devotes successive chapters to detailed descriptions of the various alloys produced in this way, and for these details the interested reader must be referred to the original memoir,

space here limiting us to a resumé of his conclusions.

Taking up some of the more important combinations studied, the following special properties may be noted:

Alloys of aluminum and tungsten, containing more than 58 per cent. of tungsten, proved to be very hard, but also extremely brittle. The same was found true of alloys of aluminum and molybdenum, and in the alloys of the latter, containing a high proportion of aluminum there appeared a tendency to an allotropic modification, causing the alloy to crumble rapidly to powder.

The various alloys of aluminum and tin were found to be very malleable and readily crushed, but those of uranium and aluminum on the contrary, were both hard and brittle.

The alloys of iron and aluminum containing more than 65 per cent. of iron were quite malleable, as were also those of aluminum and manganese.

Among the interesting combinations were the alloys of aluminum and nickel. Alloys containing from 50 to 80 per cent. of nickel were found to be very brittle, slowly falling to powder; while those containing from 80 to 95 per cent. of nickel exhibited a high degree of hardness, the maximum hardness being attained at 83 per cent. of nickel. Similar results were obtained with the alloys of cobalt and aluminum. From 42 to 83 per cent. of cobalt an extreme degree of brittleness was developed, while for combinations between 83 and 98 per cent. of cobalt a remarkably high degree of hardness was obtained, the greatest hardness appearing with 87 per cent. of cobalt.

M. Guillet accompanied his paper with a number of reproductions of micro-photographs, showing the structure of the various alloys, and also gave curves of fusibility of the more important combinations.

The importance of these researches will appear when the various combinations are given practical trials in the various branches of constructive work. It is quite possible that some of the softer alloys may become available as bearing metals, while the imparting of toughness or hardness, as the case may be, will certainly become of value. If it should be found possible to produce an alloy of great strength and hardness it might be found applicable for the production of dies for stamping metal, since such dies might be cast instead of requiring the tedious and expensive processes of cutting and hardening like steel.

While the employment of the heat of burning aluminum may not prove sufficiently economical to produce these alloys on a commercial scale, it must prove useful for purposes of research, such as M. Guillet has so successfully inaugurated.

SMOKE AND DUST.

SCIENTIFIC METHODS OF PURIFYING THE ATMOSPHERE OF TOWNS AND CITIES—ANALOGIES TO WATER AND SEWAGE PURIFICATION.

Discussions at the Sanitary Congress.

AMONG the interesting papers presented at the Manchester congress of the Sanitary Institute may be mentioned two which dealt with the important question of the purification of the atmosphere of cities and towns. One of these, by Mr. W. N. Shaw, discussed the ever present question of smoke abatement, while the other, by Sir James Crichton-Browne, M. D. dealt with the problem of dust elimination.

It is interesting to note that far greater progress has been made in the prevention of pollution to drinking water, and to the disposal of sewage, than has been effected in the purification of the air which we are compelled to breathe.

In London, at a cost to the community of £211,000 a year, or 1.38d. in the pound on rateable value, nearly a million tons of sewage are removed, day by day, from about 600,000 houses—about a ton and a half for each house, on the average. At the same time, each day in winter, each house throws into the atmosphere, on the average, perhaps, 10 tons of smoke-laden air, or a total quantity of 5 million tons of smoke-laden air for the inhabited houses of London per day, or possibly 7 million tons per day if the factories be included. The actual weight of solid soot which gives colour and body to the smoke, is a very uncertain quantity; it may, in the worst cases, amount to

nearly 3 per cent. of the coal consumed, and the houses of London probably get rid of 300 tons of solid refuse every day by throwing it up the chimney. This is mixed with much larger quantities of other more or less injurious products of the combustion of coal. The whole difference between the problem of the removal of sewage and that of the removal of smoke on similar lines, lies in the comparatively trivial distinction that under the action of the mysterious force of gravity the sewage naturally goes downwards, whereas smoke goes upwards—in the first instance, at all events. If the smoke of our fires had been in the habit of falling downwards and finding a lower level we should long ago have been driven into solving the problem of its disposal, as we have been driven to deal with the disposal of sewage.

While it is possible that the smoke which is discharged from manufacturing establishments may some day be prevented by the use of central power stations, gas producers, and internal combustion motors, the problem of the smoke emitted by private dwellings demands a different treatment. Mr. Shaw considers that it would be impracticable to establish main drains or flues for the removal of the household smoke, since it would require some forty tunnels of the size of the underground railway to deal with the smoke of London in that manner.

A more feasible treatment of the question is offered in the suggestion that it might be possible to provide precipitation chambers for each block of houses, in which the smoke could be treated before the air were permitted to pass into the outer atmosphere. It is quite possible that municipal chimneys, operated in connection with precipitation chambers might afford a means of handling the question of household smoke, without in the least interfering with the use of open fires or any other method of burning bituminous coal.

The dust problem resembles that of smoke prevention in one respect, in that it relates to the purification of the air which the residents of cities and towns are compelled to breathe. The enormous increase in the number of dust particles in city air as compared with that of the open country has been made a subject of quantitative determination. Thus, on the summit of Ben Nevis the particles of dust number about 300 per cubic centimetre, while in London they are about 150,000 per cubic centimetre, and in Paris about 210,000. It is interesting to note that in some instances the air of a small village or town is as highly polluted as that of a great city, this being explained by the fact that with the increase in the size of a city, there is not only an increase in the number of particles in the air close to the ground, but also an increase in the depth of the polluted stratum of air over the city.

The sources of dust are several, some of the most injurious dusts being those emitted by manufacturing establishments. There should be no great difficulty in dealing with these, since the sources being once definitely ascertained, proper intercepting and precipitating devices might be devised and required to be used.

A large portion of the dust in the air of great cities is due to the attrition of the pavements by the hoofs of horses and by the pulverisation of horse droppings and other organic matter. Much of this might be avoided by the use of smooth and hard pavements, and there is no doubt that the use of sheet asphalt, frequently washed and kept clean, would result in a reduction in the proportion of dust produced. Ultimately we may hope for the metallic pavement of steel, practically dustless, and free from appreciable wear.

The general introduction of motor vehicles, and the entire banishment of the horse to the country, should do much to remove from the atmosphere of the great city its most prevalent source of pollution, and this alone should form a sufficient reason for the encouragement of automobile vehicles of every description. In those cities in which electric traction has replaced horse-drawn tram cars, the improvement in cleanliness is most noticeable, and similar results would follow the removal of other sources of animal filth.

It is most encouraging to observe the question of pure air treated in a scientific manner and not second to that already applied to water and sewage disposal, and there is every reason to believe that the good work of the Sanitary Institute will do much to bring this important subject to a position which its nature demands.

THE TECHNOLOGY OF ILLUMINATION.

FROM PRIMITIVE TORCH TO ELECTRIC ARC AND INCANDESCENT VAPOUR. A HISTORICAL AND TECHNICAL STUDY.

Otto Lummer, before the Elektrotechnische Verein.

WE have become so accustomed to the brilliant and effective illumination which is found in modern buildings and public places that the rapid development in the art of artificial lighting is sometimes overlooked, and hence the address recently delivered before the Elektrotechnische Verein in Berlin by Herr Otto Lummer, and published in the *Elektrotechnische Zeitschrift* will be found of interest.

Historically, the study of illuminating devices is a most attractive subject, but its thorough investigation would take more space than could be given within the limits of a treatise. Naturally the first idea of artificial lighting came with the possession of fire, and hence a blazing brand from the fire led to the use of a torch. The search for light-emitting combustibles naturally revealed the illuminating power of oils, and with this development progress was arrested throughout mediaeval times. The great palaces of antiquity were brilliantly lighted by enormous oil lamps, differing in size only from the rag floating on a chip in a dish of melted fat, even yet in common use in Italy and other parts of southern Europe; while the candle is but a more portable form of the oil lamp, with reminiscences of the primitive torch.

At the beginning of the nineteenth century only did further progress appear with the introduction of gas lighting, and this in turn remained without much improvement for three-quarters of a century, when the competition of electric lighting entered the field.

Since then progress has been more rapid. The pressure of the competition from the electric light led to the introduction of the incandescent mantle of Auer von Welsbach, opening up a fertile field which is not yet exhausted. The arc lamp was closely followed by the incandescent filament in an exhausted bulb, and this by the enclosed arc and the Nernst glower, and to-day gas and electricity vie with each other in brilliancy and in efforts for improvement. Acetylene must be reckoned as an element in the future of illumination, and there are other gases which may yet be impressed into the service of man in his desire to turn night into day.

After a rapid resume of methods of photometry and the comparison of the relative efficiency and cost of various methods of illumination, Herr Lummer proceeds to examine the physical conditions upon which the various sources of light depend. Leaving for the present, the efforts which have been made to realize the ideal of "cold light," Herr Lummer proceeds to discuss the principles of existing methods of illumination, based upon the raising of solid materials to incandescence by heat. Existing methods of illumination involve the production and emission of a large proportion of invisible heat rays which must be surpassed in order that the far greater frequency of luminous vibrations may be attained.

The study of illumination, therefore, involves an examination into the question of the production of extremely high temperatures, as well as the relation of temperature to luminosity. The luminous effect produced by high temperatures depends upon two factors: the nature of the luminous solid, and the temperature to which it can be raised. The luminous effect is greater the higher the incandescent temperature of the solid, while the greatest efficiency is obtained, the temperatures being equal, for the substances which emit the greatest proportion of visible to invisible rays. The whole subject is one involving oxidation, and while oxidation and luminosity may occur at low temperatures, as, for example, in the luminosity of phosphorus, in nearly all cases the rapid oxidation required for high luminosity can be attained only in connection with high temperatures.

Nearly all open flame lights involve the raising of carbon to incandescence by the heat of the flame itself. When, however, the heat is raised to a maximum the carbon is completely consumed, and it becomes nec-

esary to provide some other solid substance to be raised to incandescence and luminosity. This leads at once to the idea of the Bunsen burner, producing a high heat by the complete combustion of the gas, and the employment of some incandescent substance, such as the oxides of thorium and other metals, as in the Welsbach mantle.

The principle of the electric light consists in the employment of the heating effect of the current upon a solid substance exposed to the high temperature. In the arc light the solid substance is found in the carbon points between which the arc is produced; in the incandescent lamp it is the carbon filament, the resistance of which produces sufficient heat to produce the temperature necessary for incandescence. In the more recent Nernst lamp the incandescent "glower" is composed of a non-combustible pencil of oxides, which although a non-conductor while cold, becomes of sufficient conductivity when heated to permit the passage of the electric current, while the resistance produces enough heat to maintain the temperature of incandescence. The osmium electric lamp designed by Auer von Welsbach, employs as an incandescent material the very fusible metal osmium, enclosed in a vacuum. The latest example of electric lighting is found in the mercury vapor lamp of Mr. Cooper Hewitt, in which the vapor of mercury in an exhausted tube is the incandescent substance.

In discussing all these methods of producing artificial light Herr Lummer takes up Kirchhoff's laws of the absorption and emission of light, and examines the emission of luminous and non-luminous rays.

By studying the relative emission of energy in various portions of the spectrum, he shows that the principle involved in luminosity depends upon the capacity of the luminous substance to receive all luminous rays and to reject, either by reflection or transmission, all non-luminous or heating rays. From these investigations he proceeds to discuss the laws of Stefan and Boltzmann concerning the relation of temperature to wave-length, showing that the product of the absolute temperature and the wave length is constant for the maximum production of energy, and that the maximum energy is proportional to the fifth power of the absolute temperature. He includes in the discussion a computation of the probable temperature of the sun, based upon photometric measurements, and concludes with a bibliography of articles and papers upon the modern theory of illumination.

The whole paper is an excellent resumé of the very latest information upon the production of light according to modern theories and it demands careful reading by all who are interested in this most important department of practical science.

THE LARGE GAS ENGINE.

RAPID DEVELOPMENTS IN THE CONSTRUCTION OF LARGE INTERNAL COMBUSTION ENGINES FOR GASEOUS FUEL.

H. A. Humphrey before the British Association.

AT the Paris exposition of 1900 the 600 horse-power Simplex gas engine exhibited by the Cockerill company attracted more attention than any one mechanical exhibit on the grounds. Before the close of the exposition it bore a large placard relating the number of orders which had been booked, and now engines of the same size and larger are made by several builders in Europe and America.

At the Belfast meeting of the British Association Mr. H. A. Humphrey presented a paper upon recent progress in large gas engines, giving some interesting data concerning recent gas engines of 200 horse power and over, and the record is both remarkable and significant. The limiting size has rapidly grown during the past two years as is shown by the fact that Messrs. Cockerill are now constructing an engine of 2,500 horse power, and are prepared to build a 5,000 horse power gas engine.

The development of the large gas engine is closely connected with the evolution of fuel gas processes, and it is noteworthy that the first gas engines in England above 400 horse power were operated with Mond gas, while most of the large engines on the continent have been built for use with blast furnace gas.

In August, 1902, the two leading English manufacturers had delivered or had under construction 51 gas engines, varying in size between 200 and 1,000 horse-power. Of these Messrs. Crossley Brothers, of Manchester, supply 28 engines, having an aggregate of 8,300 horse-power, or an average of 296 horse-power per engine, and the Premier Gas Engine Company, of Sandiacre, Nottingham, supply 23 engines, with a total of 9,300 horse-power, giving an average of 404 horse-power per engine. These two makers collectively supply 17,600 horse-power, and of this power 12,500 horse-power is for driving dynamos.

This is a striking proof of rapid progress, but we have to look abroad for the great achievements in this direction. Neglecting all engines below 200 horse-power, we find that Messrs Körting Brothers and their licencees have made, or have under construction, 32 gas engines, with a total of 44,500 horse-power, averaging 1,390 horse-power per engine. The Société Anonyme John Cockerill, of Seraing, and their licencees come next with 59 engines, having an aggregate of 32,950 horse-power, so that the average size of the engines built by this firm is 558 horse-power. The Gazmotoren Fabrik Deutz takes the third place with 51 engines, developing collectively 20,655 horse-power, and are followed by the Deutsche Kraftgas Gesellschaft and licencees working under the Oechelhauser patents, with engines numbering 28 and giving 16,900 horse-power A classified list of these and other large gas engines shows the remarkable total of 327 gas engines, capable of supplying 181,605 horse-power.

Although America has lagged somewhat behind the Continent in adopting large gas engines, there is evidence that this state of affairs will not long remain. The De la Vergne Refrigerating Machine Company, New York, have taken out a license to manufacture the Körting engine, and have an order for sixteen 2,000 brake horse-power engines (total 32,000 horse-power) of the Körting type; and the Lackawanna Steel Works have ordered five 1,000 brake horse-power engines for coupling to dynamos. It is only a question of time before America will be one of the largest producers of gas engines, and one enterprising American firm, the Snow Steam-Pump Works, of Buffalo, New York, have already put to successful work six 1,000 horse-power gas engines, and have now nearly completed the construction of two enormous gas engine gas-compressors of 4,000 horse-power each, the first to be running by next November and the second by January, 1903. The Westinghouse Machine and Manufacturing Company, of East Pittsburg, have made gas engines of 1,500 horse-power, and are prepared to build sizes up to 3,000 horse-power.

The general details of the large gas engines at present manufactured do not differ very materially from the smaller engines of the same makers, except in minor details incident to the increased size. The Beau de Rochas cycle maintains its hold as the simplest arrangement possible, and various combinations of several cylinders are made to obtain a greater number of impulses for each revolution of the crank shaft.

The uses to which these large engines are put are about equally divided between the operation of blowing engines for blast furnaces, and for the driving of dynamos for general power distribution, the tabulated list compiled by Mr. Humphrey for engines of more than 200 horse power, completed or in hand, showing about 99,000 horse power for driving dynamos, for light and power, and 82,650 horse power for other purposes.

The demand for internal combustion motors is doubtless a result of the general demonstration of the great economy which is obtained over the steam engine. This is due, not only to the superior thermal efficiency of the gas engine itself, but also to the fact that the gaseous fuel can be supplied from a number of sources not so available for steam making. Thus the waste gases from blast furnaces have long been burned under batteries of boilers for the supply of power for blowing and other purposes, but the use of the gas engine enables the gas to be converted into power direct, without the intervention of the boilers, while the superior economy leaves a large margin of power available for other purposes.

Producer gas can be made from fuels altogether unsuited for steaming, while the by-product processes still further diminish the cost of power and add to the advantages of gaseous over solid fuel.

ELECTRICITY IN IRON MAKING.

FUSION OF MAGNETICALLY CONCENTRATED ORES IN THE ELECTRIC FURNACE—A SUBSTITUTE FOR BRIQUETTING.

American Electrochemical Society.

IN preparing magnetic ores for the furnace by the use of the various magnetic concentrators, the resulting product is in the form of a fine powder, altogether unfit for direct use in the blast furnace. For this reason it has been attempted to compress the concentrate into briquettes of sufficient size and firmness to stand the burden of the blast furnace as well as the action of handling and shipment, and while some briquetting plants have given satisfactory results there is yet much to be desired in the methods of handling and working such ores.

At the recent convention of the American Electrochemical Society a paper was presented by Mr. Marcus Ruthenberg, discussing the application of the electric current to the preparation of magnetic concentrates, and the process is of sufficient interest to warrant discussion.

The low grade magnetites are first concentrated in some form of magnetic apparatus, of which there are several in successful use, after which the concentrates are cleaned up to the highest point of purity and then put through an electrical furnace, the melting zone of which is a magnetic field.

The ore being magnetic, the magnetic field grabs and holds the grains of magnetite, and the polar projection of this magnetic field being at the same time the electrodes of the smelting circuit, the magnetic bridge thus formed by the ore forms a high resistance in the smelting circuit. The heat of the smelting circuit, therefore, is engendered within this bridge of ore itself. The electrodes are water cooled and play no part in the melting other than to conduct the current to the ore. The moment that the ore melts it loses its magnetism, and gathering weight from new molten material being added to it it falls out of the magnetic field, its place being taken by fresh portions of ore from above. The result of this operation is agglomerated, coherent masses, ranging in size from a bean to a walnut, that are hard, strong, tough and porous, differing in analysis in no way from the ore, prior to its agglomeration except for the absence of moisture and the last traces of sulphur. The product is an ideal condition for use in the blast furnace.

In the above operation the only function played by the elctric furnace is that of fusing and agglomerating the ore, there being no reduction or other separation of metallic iron. If, however, a reducing material, such as powdered cokedust or charcoal dust be added to the charge before its introduction into the electric furnace, a partial reduction takes place, the fritted mass of carbonaceous dust and iron ore, partially melted, being permitted to drop into a soaking pit.

If allowed to remain in this soaking pit a proper length of time cementation takes place through the action of the heat left in the ore by the electric furnace, and the action of the carbon fritted into the mass, which results in producing reduced metal, which may be termed steel. Any slag forming material remaining in the ore through imperfect magnetic concentration remains with the metal. These materials in any event are comparatively small in quantity, and are just what is wanted to protect the bath of molten metal in the open hearth from the scorifying effect of the furnace. This material from the soaking pits is well adapted for melting in the open hearth furnace. It thus becomes possible to produce steel direct from the ore through the intermediary of the electric furnace and the soaking pits in the form of spongy iron or steel ready for immediate melting in the open hearth without the intervention of the blast furnace in any part. The blast furnace, while well recognized as an economical machine, is essentially a concentrator, eliminating the gangue of the ore, the limestone and the ash of the coke as a cinder or slag. It costs far less to grind and magnectically concentrate for the removal of the gangue. The blast furnace also has the disadvantage of driving whatever phosphorus there may be in the ore into the resultant pig iron. The removal from the

ore of this metal by magnetic concentration is a decided advantage over the blast furnace. It may be as well also to remember the fact that the limestone and fuel charge are never entirely free from sulphur and phosphorus, which in the action of the furnace are driven into the resultant pig iron, the phosphorus entirely and the sulphur partially. In the electric reduction limestone is practically absent, fuel in contact with the charge is lacking, and reducing material necessary for the elimination of the oxygen of the ore is small in quantity and may therefore be selected of exceptional purity without regard to its enhanced cost. Anything that will burn may be used for fuel to generate the electric current, which is the source of heat to be utilized in the reducing and melting of your ore. If water powers of magnitude be available they are sources of energy convertible into heat units not to be ignored.

The principal question concerning any such process as this lies in the commercial features. Heretofore all attempts to use electricity for the smelting of iron have been based on the complete fusion of the iron, and it has been computed that this would require theoretically from 3,000 to 3,500 kilowatt hours. The fritting operation described by Mr. Ruthenberg, however, requires much less energy, his experiments indicating that it may be effected with an expenditure of less than 500 kilowatt hours of electric energy.

Apart from the cost of power involved the question to be considered is the competition of cheap high-grade iron ores. The mining and handling of a low grade ore, containing from 5 to 10 per cent. of iron, must act to its disadvantage as compared with a 60 per cent. ore, so that there are other elements of cost to be considered besides those of the final treatment. It is possible, however, that for special purposes the electric process may be found advantageous, and ultimately the exhaustion of the available beds of high grade ore will render such concentration processes necessary.

In any event the practical use of the electric furnace for commercial smelting of metals will doubtless be advanced by just such experiments as Mr. Ruthenberg is making, and the information thus obtained will lead to further developments.

MECHANICAL AIDS TO COST-KEEPING

APPLIANCES AND METHODS FOR OBTAINING RECORDING ORIGINAL COST DATA IN THE WORKSHOP.

Discussion of the North-East Coast Institution.

THE papers presented before the North-East Coast Institution of Engineers and Shipbuilders upon various details of cost-keeping and factory accounting have attracted valuable and interesting discussions, and in the recent issue of the *Transactions* the points elicited by the papers by Mr. George Parker, and by Mr. R. P. Link, upon the methods of originating the data upon which costs are based are especially interesting.

There is no doubt that the obtaining of correct and reliable original data stands at the very foundation of any system of factory accounting, and all works managers are now practically agreed in believing that the distribution of the men's time should not be originally made by the men themselves. This being assumed, it follows that the labour of collecting the data by clerks sent through the works should be diminished as much as possible by mechanical and other devices which experience has shown to be satisfactory.

Mechanical time recorders, originally devised for keeping an indisputable record of the time of arriving and leaving the works, have now become so differentiated that they may be used in every department of the establishment, and enable divisions and subdivisions of time to be recorded with convenience and accuracy.

Apart from the use of machines for the actual recording of time, they are best employed in connection with the card system of accounting, which is steadily making its way, not only in America and Germany, but also in Great Britain, where there has been more conservatism to overcome. The British accountant especially appears to be reluc-

tant to depart from the time honoured system of books, and is disposed to mistrust the idea of cards and especially of order forms which are to accompany the work through the shop for record and entry. It is curious to observe that one of the objections which is strongly urged against the job ticket in the shop is the fact that it would become so dirty and defaced that it would be illegible by the time it returned to the office. So far from being an objection to the job order card this might better be construed as a criticism of the shops in which cleanliness is such a stranger.

As an example of the conservatism which often impedes the introduction of the systems which have been found so successful elsewhere, may be noted the very general disposition of works managers and even owners to place themselves almost invariably on the defensive, and to take the position that anything other than that to which they have become accustomed is to be opposed and criticised adversely.

The rational position to take is that of a searcher after the truth, ready to consider in a manner apart from any local or national prejudice whatever will aid in the determination of the real facts which exist in connection with the work of the establishment. The all important thing is to determine as closely as possible just exactly what takes place in connection with the passage of a piece of work through the shop. Certain things about it are true; others are only approximately so; and still others are altogether doubtful, but the truth can be had, and anything which aids in this good work should be encouraged, no matter whose prejudices are antagonized. As a matter of fact, there is no real difficulty about the determination of the entire history of every piece of work which passes through the works, if only the subject be considered as a succession of perfectly intelligible operations. Usually this can be done on a time basis, but if the development of the establishment has progressed far enough in the scale of workshop evolution, the labour cost of most of the operations will be determined upon the piece basis, in which case the question becomes mostly a matter of counting, eminently adapted for mechanical treatment.

Cost records should be made, not only for the purpose of determining minimum selling prices, but also with the object of discovering opportunities for economy. It is not enough to know how much a machine costs to manufacture, it is most essential that the manager should know why it costs as much as it does, and if the next machine or other article costs more or less than it did the last time it was made, the records should enable the portion of the work in which the difference exists to be promptly and accurately discovered. Indeed this is the most important element in a really truthful system of cost keeping. A method may give most beautifully precise results, in so far as showing a correct balance between distributed costs and wages totals are concerned, and yet be so inaccurate as to be wholly misleading to any one who might attempt to draw useful conclusions from it. If the one great object of the ascertainment of the exact truth about the methods and conditions of the conduct of the establishment be made the criterion by which a cost system be judged, the atmosphere would be greatly cleared from much of the fog which now obscures it.

The treatment of establishment charges is one which is often considered in a deceptive manner. Some managers appear to feel that establishment charges are in themselves something discreditable, and that if they can be so apportioned amongst the various machine operations as to be concealed as expense charges, they are no longer objectionable. A really truthful system of cost keeping permits nothing to be charged directly to a piece of work but that which it has really and definitely caused, and if establishment charges are to be rationally reduced it can only be by their being really understood. The same is true of depreciation charges, and the fact that a tool still stands on the inventory at a positive value does not at all prevent it from being a venerable candidate for the scrap heap.

The most important thing about the whole business is for owners and works managers to abandon the ostrich-like tendency to bury their heads in the sand and believe that they can avoid the detection which is in many instances awaiting them in the form of ruinous competition from rival establishments whose only strength lies in the fact that they know exactly what they are doing and why they are doing it.

THE BEAUMONT OIL FIELD.

GEOLOGICAL AND INDUSTRIAL CONDITIONS ACCOMPANYING THE DEVELOPMENT OF THE OIL FIELDS OF THE TEXAS REGION.

American Institute of Mining Engineers.

SO much has been published about the oil fields of Texas which bears the evident impress of the promoter, that it is most satisfactory to receive the scientific paper of Mr. Robert T. Hill, contributed to the *Transactions* of the American Society of Mining Engineers, giving a reliable account of the whole region.

Mr. Hill discusses at length the sedimentary rocks of the Texas oil region connected with the oil problem, showing that they are by no means all of the same geological period, all however belonging to the Cretaceous and later ages. The first well, bored by Captain Lucas, passed through 1,100 feet of clay and quicksand, and the oil when struck had a temperature of more than 110°F.

Since the beginning of 1901, when the first gushing well was struck, the production has increased until it is estimated that the output for 1902 will reach 20,000,000 barrels.

The location of the fields is an important factor in their commercial development. Three pipe lines have been finished, two to Port Arthur, 19 miles long, and one to Sabine, 24 miles long. Other lines are planned, so that there will be no difficulty in delivering the oil to seaports, independently of any railway complications. At the same time there are extensive railway facilities, and the transport problem is one which requires only sufficient time to be solved in more ways than one.

The applications of the oil are well described by Mr. Hill:

"Within a year from its discovery, Beaumont oil is burning in Germany, England, Cuba, Mexico, New York and Philadelphia. By its energy steamers are being propelled across the ocean, trains are hastening cross the continent, electricity generated and artificial ice frozen in New York, ores ground and stamped in Mexico, Portland cement manufactured in Havana and Texas, and gas enriched in Philadelphia; and this, too, while half the world is either unaware or incredulous of the value of this fuel."

The occurrence of the oil with much sulphur, sulphuretted hydrogen, and salt has complicated the theories of its origin, and as yet no altogether satisfactory hypothesis has been offered. Mr. Hill, however, taking the experimental data collected by Captain Lucas, offers a theory which he sets forth as follows:

"The hypothesis is offered with hesitation, not as a final explanation, but in the hope that it may serve as a basis for discussing through which the truth may be reached. I think it fully interprets the Lucas group of phenomena, and accounts for the mystery of Spindle Top far more satisfactorily than any other thus far presented; and that it may also account for the independent origin of the sulphur, sulphuretted hydrogen and gypsum, regardless of their association with the oil.

The hypothesis is as follows: The oil- and salt-pockets of the Texas Coastal Plain are probably not indigenous to the strata in which they are found, but are the resultant products of columns of hot saline waters which have ascended, under hydrostatic pressure, at points along lines of structural weakness, through thousands of feet of shale, sand, and marine littoral sediments of the Coastal Plain section, through which oil and sand are disseminated in more or less minute quantities. The oil, with sulphur, may have been floated upward on these waters, and the salt and dolomite may have been crystallized from the saturated solution.

"The channels of these ascending waters may have been in places of structural weakness, such as fissures, which probably at one time continued to the surface, but may have been sealed by the deposition of the later overlapping strata now capping the oil-pools. Such features, when occurring under gentle anticlines, may explain the collection of oil beneath the surface in pools."

The importance of the experience which is being gained with the Texas fuel oil comes with especial force and value in the light

of the effect of the strike in the anthracite coal regions of Pennsylvania. The greater the number of fuel resources, the less the probability of a deficiency in the supply at any one time. It is altogether possible that those establishments which must be independent of artificial restrictions in the supply of fuel will hereafter equip themselves for oil fuel as well as coal, and use whichever is most available, the possibilities of a stoppage being far more remote in such circumstances. For marine purposes it is possible that oil fuel may solve the problem of the stoking of boilers mechanically at sea, and thus remove the difficult question of hand stoking, with all its labor troubles.

THE HEAT TREATMENT OF STEEL.

OVERHEATING AND ANNEALING—POPULAR FALLACIES CONCERNING THE BEHAVIOUR OF STEEL UNDER HEAT CONTROVERTED.

Prof. Heyn, before the Iron and Steel Institute.

IT is a rather interesting fact that whenever any one comes out with some startling proposition concerning principles which it is supposed were definitely settled, various people rise up at once to say that they knew it all long ago. Thus it has been generally accepted that steel was made tough by heating it to a full red and allowing it to cool very slowly. The high heat was considered to be best applied for several hours, and the cooling prolonged through several days. Now, in his paper presented before the Iron and Steel Institute at Düsseldorf, Professor Heyn, of Charlottenburg, says that when low-carbon mild steel is annealed at temperatures above 1,000 degrees C. there occurs an increase in brittleness if the annealing period is sufficiently long. This action Professor Heyn calls "overheating," and he takes care to distinguish carefully between this and what is called "burning." Overheating is distinctly limited to include changes, due to heat, of a purely physical character, unaccompanied by any chemical change, while burning conveys the idea of a process of combustion, the taking up of oxygen by the metal, involving a chemical change.

The general phenomena observed by Professor Heyn may be summed up as follows:

If it is attempted to anneal steel at a temperature above 1,000° C., the brittleness increases, growing with the increase in temperature and with the duration of the process. For temperatures between 700° and 890°, no increase in brittleness is produced, however prolonged the annealing. It is, therefore, possible so to regulate the temperature and time to produce any desired degree of brittleness. The temperature at which the brittleness increases with time lies somewhere between 900° and 1,100°. The effects of overheating do not require the extreme white heat for their production, appearing at considerably lower temperatures, it being only necessary to give sufficient time to produce the most marked effects.

As a result of these facts, the process of annealing, to be effective, must be carried out with certain precautions. Taking a temperature of 900° C., which should not be greatly exceeded, a short period, say about half an hour, is sufficient, and in fact, longer annealing should be carefully avoided; and the nearer the temperature limit of about 1,000° C. is approached, the shorter should be the time during which it is maintained. It is important, however, that the temperature should be at least 900° C., since below that heat an annealing of several hours is not sufficient to remove brittleness, although the desired result can be attained by annealing at a temperature between 700° and 850° for several days.

The discussion of the paper brought some experiences of other observers which fully confirm and supplement Professor Heyn's researches. Thus Mr. Stead stated that while steel could be made tough by heating it to temperatures under 1,000° C., it would be made brittle by raising it to 1,200°. A short heating to a high temperature of a brittle steel with a coarse grain, will produce a fine grain, while the same result will be obtained by a longer heating at a lower temperature.

Another element to be taken into consideration is the size of the piece under treatment, since time is required for the rearrangement of the particles to take place.

The most important fact of the whole subjeit is that brittleness can be entirely removed by raising the steel to the proper temperature for but a single minute and then permitting it to cool in the air at once. It can be made entirely a matter of temperature but the temperature must be just right; if too low, the brittleness will not be removed, if too high, overheating will occur.

The importance of this fact in practical work cannot be overestimated. Failure in structural work doubtless arises often from brittleness in the material, a defect not revealed by chemical analysis nor by the usual tensile tests. If, however, freedom from brittleness can be entirely assured by such a methodical operation and rapid heating and immediate cooling, the only essential being the strict maintenance of the proper temperature, there is no permissible reason for the use of any brittle material in a steel structure. As Mr. Stead put it: If, in the future, lives are lost by the failure of a properly designed steel structure, those who have neglected the reheating process should be held guilty of manslaughter.

THE AMERICAN ELECTROCHEMICAL SOCIETY.

RAPID DEVELOPMENT OF AN ORGANIZATION REPRESENTING A NEWLY CREATED DEPARTMENT OF INDUSTRY.

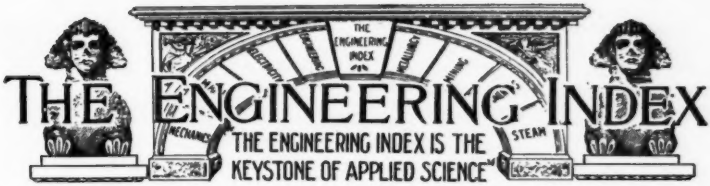
Convention at Niagara Falls.

IT has been observed that in some respects the science of electrical engineering is becoming more and more a department of mechanical engineering, the great power stations and applications containing much more mechanical than electrical work, but this cannot be said of the recently developed and rapidly growing electrochemical industries. The mere fact that this department of applied science has become of sufficient magnitude to maintain a large and prosperous professional society is evidence of its prominence and activity.

It is interesting to note that the real development of modern chemistry owes much of its progress to the electrochemical researches of Davy and of Faraday, but it was not until the arrival of the dynamo and hydroelectric station, providing an ample supply of cheap electrical energy, that it became possible to turn the tables and enlist electricity as an effective agent in the industries of manufacturing chemistry. Now that this has been done, however, the art has progressed so rapidly that the older methods of chemical manufacture are constantly undergoing revision, while new products, hitherto not produced artificially, have been added to the list of marketable supplies.

Niagara Falls is an especially appropriate situation for a meeting of electrochemists, since it is there that the greatest installations of electrical manufacturing of chemical products are operated. It is only necessary to mention the subjects of aluminum, carborundum, artificial graphite, calcium carbide, caustic alkalies, artificial nitric acid, etc., etc., to show to how great an extent the electrochemical industries have been dependent upon the great power plants at Niagara Falls for their existence.

It is unfortunate, however, that the policy of secrecy and isolation which has distinguished the electrochemical industries at Niagara Falls should have been maintained during the convention of men best qualified to appreciate them. It has been the experience of all other technical societies that the open handed hospitality of all the establishments in their especial lines has been of great value to the hosts as well as to the visitors. The men who welcome all visitors to their works make no mistake in so doing, they might, if it were necessary, plead selfishness as a reason for their open doors, since they may learn more than they teach. In other departments of engineering it is well appreciated that the days of old-time secretiveness are past, and that a man who has to conduct his work behind closed doors is not likely to keep up in the van of the procession. Doubtless as the managers of the electrochemical industries become interested in the work of the society they will learn to abandon their present unfortunate attitude, and realize that they have as much, if not more to learn than they have to show.



The following pages from a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world,—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

Heavy Concrete Arches. Describes a double 50-foot concrete arch bridge, having a greater thickness of arch width than is ordinarily used. 1000 w. Eng Rec—Aug. 30, 1902. No. 50314.

The Computation of Circular Arched Girders (Beitrag zur Berechungsweise der Kreisbogenträger). Adolf Francke. With formulas and diagrams for the determination of stresses in circular braced arches with joints at various points. 3000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Aug. 23, 1902. No. 50744 B.

The Proper Curvature for a Filled Arch. Daniel B. Luten. Discusses points in the construction and design. 2000 w. R R Gaz—Sept. 12, 1902. No. 50517.

Bridge Terminal.

A Proposed New Brooklyn Bridge Trolley Terminal Plan. A brief illustrated explanation of the plan designed by Mr. Neils Poulson. 500 w. Eng News—Sept. 11, 1902. No. 50507.

Brooklyn Bridge.

Plan for Relieving Brooklyn Bridge. Illustrations and plans with description of changes proposed by Neils Poulson, for relief of the congestion of traffic at the

We supply copies of these articles. See page 325.

Manhattan terminal. 900 w. St Ry Jour —Sept. 20, 1902. No. 50660 D.

East River Bridge.

The Footbridge for Building the Cables of the New East River Bridge, New York. Isaac Harby. Gives a brief description of the cables and a statement of the conditions encountered, with an illustrated description of the construction of the foot bridge, giving the reasons for constructing it. 6300 w. Pro Am Soc of Civ Engrs—Sept., 1902—No. 50686 E.

Fraser River.

A New Bridge Over the Fraser River at New Westminster, British Columbia. An illustrated detailed description of a bridge having two decks, one for wagon traffic and the other for steam and electric railroad traffic. 1700 w. R R Gaz—Aug. 29, 1902. No. 50270.

North Wales.

Bridge Over Llyfni. Illustrates and describes a bridge of rather unusual construction recently erected by the owners of the South Dorothea Slate Quarry at Nantile, North Wales. 600 w. Engr, Lond—Aug. 22, 1902. No. 50365 A.

Old Bridges.

Unit Stresses and Impact in Old Railway Bridges. A. F. Robinson. Abstract of a lecture delivered at the Univ. of Illinois. Discussing what is the highest unit stress that may be permitted in old metal bridges, and how long the structures will be apt to last. 2000 w. Eng News—Sept. 25, 1902. No. 50676.

Reinforced Concrete.

Concrete-Steel Bridges. D. B. Luten. Considers the suitability of this material for bridge construction, giving illustrated descriptions of the method of design used. 1300 w. Munic Engng—Sept., 1902. No. 50329 C.

Viaduct.

The Eighteen Mile Creek Viaduct. Illustrated description of the method of replacing a double-track viaduct with a new structure at the same grade on the same piers, without interrupting traffic. 2300 w. Eng Rec—Sept. 20., 1902. No. 50641.

CANALS, RIVERS AND HARBORS.

Altona.

The Enlargement of the Harbor of Altona (Erweiterung des Altonaer Hafens). H. v. Horn. With details of the new dyke by which the new harbor is enclosed and protected from storms and ice. 2000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Sept. 13, 1902. No. 50746 B.

Barge Canal.

The New York Barge Canal Project Again. Editorial, discussing the report against the Ontario route just rendered by the committee of Canal Assn. of Greater N. Y. 1600 w. Eng News—Sept. 11, 1902. No. 50506.

Breakwater.

See Civil Engineering, Materials.

Canal Haulage.

See Electrical Engineering, Power Applications.

Coast Protection.

The Protection and Improvement of Foreshores by the Utilization of Tidal and Wave Action. R. G. Allanson-Winn. Discusses how to permanently safeguard a line of frontage from the erosive action of the sea at low cost, commending the system of groyning discovered by Edward Case. Ill. 7000 w. Pro Am Soc of Civ Engrs—Aug., 1902. No. 50428 E.

The Sea Coast. A review of a recent book, by W. H. Wheeler, containing a wonderful amount of information concerning coasts, defensive works, sea walls, groynes, etc., especially as regards the coasts of England. Ill. 5400 w. Builder —Sept. 6, 1902. No. 50551 A.

Dams.

A Proposed New Type of Masonry Dam. Discussion of the paper by George L. Dillman. 2700 w. Pro Am Soc of Civ Engrs—Aug., 1902. No. 50435 E.

A List of Failures of American Dams. W. R. Hill. An annotated list from the presidential address before the Am. W. Wks. Assn. 4400 w. Eng Rec—Sept. 27, 1902. No. 50822.

Construction of the Lauchensee Dam. Condensed from the *Zeitschrift für Bauwesen*. H. Frecht. An outline of construction methods used in a difficult and expensive masonry dam built to increase the low-water flow in the streams of the Vosges Mountains. 2700 w. Ill. Eng Rec—Aug. 30, 1902. No. 50310.

Reconstruction of the Lake Winnibigoshish Dam. Illustrated description of a movable dam having five drum gates of the Tainter type and a reversed bear-trap gate. 3200 w. Eng Rec—Sept. 13, 1902. No. 50524.

The Break in the Utica Reservoir. Illustrated description of the manner in which a 70 ft. earth dam failed. 600 w. Eng Rec—Sept. 27, 1902. No. 50821.

The San Leandro Earth Dam of the Oakland Water Works. Burr Bassell. An illustrated description of a high earth dam originally built in 1874-5, but since raised to a height of 125 ft. above the original surface, 155 ft. above the bottom of the central puddle trench, and 158 ft. above the bottom of the concrete-filled secondary trenches. A large part of the embankment was sluiced in by the hydraulic process. 1300 w. Eng News—Sept. 11, 1902. No. 50504.

We supply copies of these articles. See page 325.

Dredging.

Dredging Machines. John Bogart. Read before the International Nav. Cong. at Düsseldorf. Deals with the construction, capacity, and cost of operating dredging machines of several types in recent excavations of large magnitude. 5600 w. Engng—Aug. 29, 1902. No. 50473 A.

The Cost of Dredging with Different Classes of Plant. John Bogart. Condensed paper read before the International Nav. Cong. at Düsseldorf. Describes centrifugal pump, dipper and vacuum pump dredgers employed in excavating 1,500,000 cu. yds. of clay and earth, and gives itemized cost of excavation with each class. 5000 w. Eng Rec—Sept. 13, 1902. No. 50523.

Dry Dock.

A New Japanese Dry Dock. Illustrates and describes the Kawasaki Company's dry dock at Kobe, built wholly under the direction of native trained experts. Many difficulties were met, but the construction seems practically perfect. 2400 w. Engng—Aug. 22, 1902. No. 50369 A.

Floating Dock.

Durban Floating Dock. Illustrates and describes the launch of this floating dock built to the order of the Natal Government. 1000 w. Engrs' Gaz—Sept., 1902. No. 50465 A.

Isthmian Canal.

Sanitary Problems Connected with the Construction of the Isthmian Canal. Geo. M. Sternberg. Considers how best to avoid unnecessary sacrifice of life by those employed on this great work. 3700 w. N Am Rev—Sep., 1902. No. 50321 D.

Locks.

A New Canal-Lock System (Ein Neues Sparschleusen-System). Prof. L. Czischek. A description of the Tenscher-Czischek systems in which a rolling cylinder displaces the water necessary to effect the desired difference in level. 4500 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Aug. 29, 1902. No. 50729 B.

Lighthouse.

The Lighthouse at L'Ile Vierge. Illustrations and description of a recently completed lighthouse off the coast of Brittany, which has the distinction of being the most lofty yet erected. 2800 w. Engng—Aug. 22, 1902. No. 50368 A.

Nile.

The Nile Irrigation Works. An illustrated article describing the great dam at Assouan, the locks, sluices, etc. 2000 w. Sci Am—Sept. 20, 1902. No. 50601.

Piles.

Sinking and Testing an Iron Pile. Describes the method of sinking a pile at Hoboken, N. J., at the foot of pier C in the North River. 1600 w. Eng Rec—Aug. 30, 1902. No. 50315.

River Improvement.

Improvement of the Black Warrior, Warrior and Tombigbee Rivers, in Alabama. Discussion of the paper by R. C. McCalla. 7800 w. Pro Am Soc of Civ Engrs—Sept., 1902. No. 50687 E.

CONSTRUCTION.

American Methods.

The American Engineer in England. William G. Sloan. Describes the work of building the plant of the British Westinghouse Elec. & Mfg. Co., comparing English and American methods and giving many interesting facts. Ill. 5200 w. Jour W Soc of Engrs—Aug., 1902. No. 50286 D.

Building Construction.

The Bank of the State of New York. Illustrated description of a 25-story, steel-cage structure resting on foundation piers sunk by the pneumatic process, and showing many unusual details in the wind bracing and connections of the steel-work. 3800 w. Eng Rec—Sept. 13, 1902. No. 50521.

Dams.

See Civil Engineering, Canals, Rivers, and Harbors.

Dome.

Steel Dome for West Baden, Ind., Hotel; the Largest Dome in the World. Views, drawings and description of this great structure. 1000 w. Eng News—Sept. 4, 1902. No. 50394.

Foundations.

Lowering a Heavy Foundation Girder. Illustrated description of the method used in constructing the foundations of a large steel-cage, twenty-story office building in New York. 1100 w. Eng Rec—Aug. 30, 1902. No. 50318.

Office Building.

The Blair Building, New York. Illustrated description of the construction of a 20-story, steel-cage office building in New York. 3000 w. Eng Rec—Sept. 6, 1902. No. 50448.

Pavements.

See Civil Engineering, Municipal.

Permanence.

Relative Permanence of Steel and Masonry Construction. Informal discussion of whether steel is susceptible of being made as permanent a building material as masonry. 4000 w. Pro Am Soc of Civ Engrs—Aug, 1902. No. 50431 E.

Roads.

An Appreciative Analysis of Macadam Road Construction. C. H. W. Biggs. Read at the Bristol meeting of the Incor.

We supply copies of these articles. See page 325.

Assn. of Munic. & Co. Engrs. Gives the writer's views on proper construction of roads. 1300 w. Builder—Aug. 30, 1902. No. 50453 A.

Notes Concerning Road Construction. Describes the method employed in building the State aid roads in New York. Also gives the recent experience of the State roads of Massachusetts. 1800 w. Eng Rec—Aug. 30, 1902. No. 50313.

Road Grades. C. H. Fitch. A discussion of some points in road surveying and construction. 1400 w. Min & Sci Pr—Sept. 6, 1902. No. 50494.

The Adjustment of Macadam Road Design to Various Subgrade Soils. From the report of the Massachusetts Highway Commission, describing methods employed. 700 w. Eng News—Sept. 4, 1902. No. 50400.

Skeleton Construction.

The New York Steel Buildings. From the *Birmingham Daily Post.* Extract from an article giving a description of the latest manner of building in New York, as it appeared to an Englishman. 2500 w. Archt, Lond—Sept. 5, 1902. No. 50552 A.

The Steel Framework of the Farmers' Bank Building, Pittsburg, Pa. An illustrated description of the steel structural work of a 24-story office building. 4200 w. Eng News—Sept. 18, 1902. No. 50590.

Tunnels.

Difficult Work in Repairing a Swiss Railway Tunnel. Illustrates and describes methods of repairing a rock fall which was so serious that traffic was interrupted for 53 days. 900 w. Eng News—Sept. 25, 1902. No. 50675.

Difficult Work on the Meudon Tunnel on the New Railway from Paris to Versailles. Translated from *Le Génie Civil.* An illustrated description of interesting work because of the difficulties encountered. 1800 w. Eng News—Sept. 11, 1902. No. 50505.

The Simplon Tunnel (Simplon Tunnel). An abstract of the quarterly report of progress on the Simplon tunnel, showing the work and operative conditions from March to June, 1902. 2000 w. Schweiz Bauzeitung—Aug. 30, 1902. No. 50737 B.

Underpinning.

Complicated Underpinning. Illustrated description of methods of supporting high walls where the working space was unusually restricted. 2000 w. Eng Rec—Sept. 27, 1902. No. 50826.

MATERIALS.

Building Stone.

The Stone Resources of Washington. The first of a series of illustrated articles giving an account of the building stones of this state, and their development. 2200 w. Stone—June, 1902. Serial. 1st part. No. 50478 C.

Concrete.

Materials for the Concrete of the Buffalo Breakwater. Emile Low. Illustrated article giving details of this work, which is a departure from ordinary methods as usually practiced in concrete construction. 2500 w. Eng News—Sept. 11, 1902. No. 50502.

Submarine Concrete Work at the Nussdorf Locks (Betonierungen unter Wasser bei der Schleusen-Anlage in Nussdorf). Emil Grohmann. Giving details of the apparatus for mixing and delivering the concrete to the submarine foundations. Two articles, 7500 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 22, Sept. 12, 1902. No. 50730 each B.

Reinforced Concrete.

Concrete-Steel Theory and Computations. Editorial discussion of the experimental facts available for testing the value of formulas for the strength of concrete steel beams and posts, and of the best form of formulas for practical use. 1400 w. Eng Rec—Sept. 13, 1902. No. 50520.

See Civil Engineering, Bridges.

Rust Prevention.

Tests of Various Paints on the 155th St. Viaduct, New York City. Reprinted from the N. Y. *Evening Post.* A report of the second examination of the paints applied in 1897 with a view of determining their comparative protective qualities. 1000 w. Eng News—Sept. 4, 1902. No. 50397.

The Chemistry of the Protection of Steel Against Rust and Fire by Concrete. Notes supporting the evidence of the efficiency of this protection. 1700 w. Sci Am Sup—Sept. 20, 1902. No. 50602.

Wood Preservation.

The Rapid Ageing and Fireproofing of Wood. Translated from the *Revue de Chémie Industrielle.* Gives a brief analysis of the principal methods which have given fairly good results, and describes the Nodon and Bretonneau process which utilizes electricity. 6300 w. Sci Am Sup—Sept. 6, 1902. No. 50405.

MEASUREMENT.

Base Measurement.

Rapid Base Line Measurement for the Ninety-Eighth Meridian Triangulation. Illustrated description of methods followed by the U. S. Coast and Geodetic Survey in which steel tapes were employed in comparison with older methods. 4900 w. Eng Rec—Sept. 27, 1902. No. 50823.

The Base Line Measurements for the 98th Meridian Triangulation. John F. Hayford. Gives the principal features of this work, calling attention to departures

from past practice. Of value as a record of rapid and economical measurement of bases of a primary degree of accuracy. Ill. 5400 w. Eng News—Sept. 4, 1902. No. 50396.

Surveys.

A brief discussion of the Law of Boundary Surveys. William E. Kern. 6000 w. Eng News—Aug. 28, 1902. No. 50267.

MUNICIPAL.

Contracts.

See Civil Engineering, Miscellany.

Garbage Destruction.

Engineer's Report on the Garbage Furnaces of Trenton, N. J. A reprint of the report of Mr. Rudolph Hering, which is a comprehensive study of conditions at Trenton and of garbage cremation in general. 8500 w. Eng News—Sept. 11, 1902. No. 50508.

Municipal Ownership.

See Industrial Economy.

Pavements.

Pavements in General. Charles E. P. Babcock. Notes concerning asphalt pavements principally. 3500 w. Jour Assn of Engng Socs—Aug., 1902. No. 50694 C.

Paving a Country Road with Brick. Samuel Huston. Slightly condensed from a paper read before the Ohio Soc. of Civ. Engrs. & Surv. A statement of the conditions where the road is located with a description of the construction. 1700 w. Eng News—Sept. 25, 1902. No. 50673.

Street Paving. B. F. Fendall. Read at meeting of the League of Am. Munic. Gives the experience in Baltimore. Recommends bituminous pavements, and suggests a combine of cities to reduce the price of asphalt. Ill. 2200 w. Munic Jour & Engr—Sept., 1902. No. 50291 C.

Roads.

See Civil Engineering, Construction.

Sewage Disposal.

Sewage Purification Experiments at York, England. A review of the report of Mr. Alfred Creer, concerning careful investigations made. 3300 w. Eng Rec—Sept. 6, 1902. No. 50446.

The Bacterial Treatment of Trades Waste. William Naylor. Abstract of a paper read before the Inst. of Civ. Engrs. Describes experiments at bleaching works, print works, breweries and dye works. 4000 w. Eng Rec—Sept. 20, 1902. No. 50644.

Sewers.

A 27 and 30-inch Concrete Sewer. Illustrated description of the methods of construction of an unusual type of storm-water sewer recently completed at Truro, Nova Scotia. 1500 w. Eng Rec—Aug. 30, 1902. No. 50311.

WATER SUPPLY.

Artesian Wells.

An Engineering Commission on the Artesian Wells of the Memphis Water Works. A recent study of this system which forms a part of a report of a commission of engineers appointed by the city authorities to report on the "condition and value" of the works. 6100 w. Eng News—Sept. 25, 1902. No. 50677.

The Kasusa System of Artesian Well Boring in Japan. Describes method used to bore wells of great depth. 1200 w. Eng News—Sept. 4, 1902. No. 50938.

Ground Water.

Underground Water. Editorial discussion of a case recently brought before the English courts. 1500 w. Engng—Aug. 22, 1902. No. 50373 A.

Irrigation.

Notes on Irrigation Engineering. Extracts from testimony by Elwood Mead before the U. S. Industrial Commission, on the losses of water by seepage from canals, the filling of canals by silt, and the filling of reservoirs by silt. 2700 w. Eng Rec—Sept. 20, 1902. No. 50643.

See Industrial Economics.

Organisms.

Crenothrix as a Source of Trouble in Public Water Supplies. Extracts from a paper by Daniel D. Jackson, printed in *The Journal of the Society of Chemical Industry*, on "The Precipitation of Iron, Manganese and Aluminum by Bacterial Action." 800 w. Eng News—Sept. 4, 1902. No. 50402.

Ozone.

The Purification of Drinking Water by Ozone (Die Reinigung des Trinkwassers durch Ozon). Dr. H. J. van't Hoff. A review of the methods thus far applied, with tabulated data and results of tests in Holland, Belgium, France, and Germany. 1500 w. Zeitschr f Elektrochemie—July 24, 1902. No. 50768 G.

Pipe.

Standard Specifications for Cast-Iron Pipe. Gives specifications adopted by the New England Water Works Assn., with notes on their special features. 2200 w. Eng Rec—Sept. 13, 1902. No. 50522.

Rates.

"Fair, Just and Reasonable Water Rates." A discussion from the point of view of a private company, of certain factors to be considered in determining rates. 2500 w. Eng Rec—Sept. 20, 1902. No. 50642.

Reservoirs.

A New Covered Reservoir at Newton, Mass. Describes especially the covering, which is of flat concrete steel construction.

We supply copies of these articles. See page 325.

Ill. 1200 w. Eng Rec—Aug. 30, 1902. No. 50312.

The Construction of a Reservoir and Standpipe on Forbes Hill, Quincy, Mass. C. M. Saville. An illustrated detailed account of the construction work, cost, etc. 14800 w. Jour N E W Wks Assn —Sept., 1902. No. 50438 F.

Rural Supplies.

Rural Water Supplies. James Dewhirst and Horace G. Keywood. Read at Leicester meeting of the Brit. Assn. of W. Wks. Engrs. Chief points of the paper and discussion. An account of what has been done in the Maldon and Chelmsford districts. 5500 w. Jour Gas Lgt—Aug. 16, 1902. No. 50357 A.

Statistics.

Water Works Statistics for the Year 1901, in Form Adopted by the New England Water Works Association. Compiled by Charles W. Sherman. Tabular report of pumping statistics, financial statistics, consumption, distribution, etc. 1500 w. Jour N E W Wks Assn—Sept., 1902. No. 50439 F.

Water Rights.

A Complication of Water Rights. Condensation of the opinion rendered in a case in Utah, which is of interest to hydraulic engineers and managers of water works. 3500 w. Eng Rec—Aug. 30, 1902. No. 50320.

Water Works.

An Unusual Water Supply Plant. Describes works at Arad, Hungary, having air lifts and Fischer filters. 1200 w. Eng Rec—Sept. 27, 1902. No. 50824.

Wisconsin, U. S. A.

Wisconsin Water Supplies. W. G. Kirchoffer. Gives the history, sources of supply, quality and treatment of waters, population supplied, etc. 3800 w. Municipality—Sept., 1902. No. 50426.

MISCELLANY.

Contracts.

Municipal Contract System. Thomas G. Hayes. Read before the League of Am. Munic. Describes the Baltimore system and gives reasons for favoring the method adopted. 1500 w. Munic Jour & Engr—Sept., 1902. No. 50292 C.

Unreasonable Contract Requirements by the Government. A discussion of the futility and unreasonableness of specifications forcing all the risk of a difficult work on the contractor without giving him reasonable compensation. 1700 w. Eng Rec—Sept. 20, 1902. No. 50640.

Engineering Ethics.

The Regulation of Engineering Practice by a Code of Ethics. Informal discussion of whether engineering practice should be so regulated, and if so, how such a code can be established. 7500 w. Pro Am Soc of Civ Engrs—Aug., 1902. No. 50434 E.

Specifications.

An instructive Study of Specifications. Extracts from a specification recently issued by the Bureau of Yards and Docks of the U. S. Navy, for the building of a masonry dry dock at Charleston, S. C., to cost about one million dollars, with comment. 3700 w. R R Gaz—Sept. 12, 1902. No. 50515.

Engineers, Contractors and Specifications. Editorial discussing the troubles arising from prevailing practice. 2500 w. Eng News—Sept. 18, 1902. No. 50589.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cable Relay.

Automatic Relay Translation for Long Submarine Cables. S. G. Brown. Read before the Inst. of Elec. Engrs. Illustrates and describes a system in every day use on some of the lines of the largest cable companies. 4000 w. Sci Am Sup—Sept. 20, 1902. No. 50603.

Vibrating Cable Relay. K. Gulstad. On the working of the apparatus which has given favorable results with some of the cables of the Great Northern Telegraph Co. Ill. 1800 w. Elec Rev, Lond—Aug. 22, 1902. Serial. 1st part. No. 50350 A.

Common Batteries.

Common Battery Points. J. C. Kelsey. A discussion of some of the defects of common batteries for telephone systems and the means of remedying them. 2700 w. Telephony—Sept., 1902. No. 50414.

Space Telegraphy.

On Some Phenomena Affecting the Transmission of Electric Waves Over the Surface of the Sea and Earth. H. B. Jackson. Read before the Royal Soc. Describes results of phenomena observed during experiments, and gives conclusions drawn as to their cause. 2400 w. Elec Rev, Lond—Aug. 22, 1902. Serial. 1st part. No. 50351 A.

Telegraphy Without Wires (La Télégraphie sans Fil). G. Espitallier. A general study of the practical apparatus for

the use of magnetic waves for telegraphing through space. Serial. Part I. 3000 w. Génie Civil—Sept. 6. 1902. No. 50726 D.

Wireless Telegraphy and Maxwell's Theory. Frederick K. Vreeland. On the value of Maxwell's theory in furnishing an explanation of the greater facility of transmission over water than over land, and of other perplexing problems. 2800 w. Elec Wld & Engr—Sept. 13, 1902. No. 50544.

Telegraphy.

The Evolution of Electrical Telegraphy. Perry F. Nursey. A brief article showing that the idea embodied in the telegraph was expressed in the writings of Galileo, Shakspeare and early writers, though not made practical until the last century. 1700 w. Elec Engr, Lond—Aug. 29, 1902. No. 50457 A.

Telephony.

The Designing of Telephone Apparatus. W. A. Taylor. Discussing points of importance representing the best practice. 2600 w. Elec Rev, N Y—Sept. 13, 1902. Serial. 1st part. No. 50539.

The Housing of a Telephone Plant. Herbert Laws Webb. An illustrated article tracing the evolution of the modern telephone exchange building. 4800 w. Elec Wld & Engr—Aug. 30, 1902. No. 50277.

Underground Work for Telephone Exchanges. Arthur V. Abbott. The first of a series of articles dealing with the conductive system, describing the details of the plant, calculating cost, etc. 1300 w. Elec Wld & Engr—Aug. 30, 1902. Serial. 1st part. No. 50279.

DISTRIBUTION.

Great Britain.

The Electrical Power Distribution Systems of Great Britain. An outline map showing the areas and situations occupied by the respective schemes with some particulars relating to them. 1500 w. Elec Rev, Lond—Sept. 12, 1902. No. 50622 A.

Three-Wire.

Distribution with Uninsulated Neutral. E. Morgan. Discusses this question and its advantages, and suggests a system of distribution. 1000 w. Elec Rev, Lond—Aug. 29, 1902. No. 50462 A.

Re Earthing the Middle Wire in Three-Wire Distributing Systems. G. Hooghwinkel. Presenting the advantages of using a bare neutral wire. 1500 w. Elec Rev, Lond—Aug. 29, 1902. No. 50460 A.

Wiring.

Some Notes on Electric Wiring. George A. Clark. Read at Glasgow meeting of the Inst. of Elec. Engrs. Pointing out a few of the more serious defects in the present methods, and where possible, suggesting a remedy. 2500 w. Elec Engr, Lond—Sept. 5, 1902. No. 50613 A.

ELECTRO-CHEMISTRY.

Accumulators.

Deterioration of Storage Battery Plates. A. L. Marsh. Considers the principal defects which tend to shorten the life of lead batteries and also of other types, and suggests lines upon which improvements may be made. 3000 w. Elec Wld & Engr—Sept. 13, 1902. No. 50546.

The Life and Weight of Accumulators (Zur Frage der Lebensdauer und des Gewichtes der Akkumulatoren). Dr. J. Rabinowicz. A discussion of the various materials available for accumulator construction with a view to reduction in weight. 1200 w. Elektrochemische Zeitschr—Aug., 1902. No. 50773 G.

Alkalies.

The Electrolysis of Fused Caustic Soda and Potash (Die Elektrolyse von Geschmolzenem Aetznatron und Aetzkali). MM. Leblanc & Brode. An examination of the operation of the Castner process, as conducted at Neuhausen, in the light of the authors' experiments. Serial. 3500 w. Zeitschr f Elektrochemie—Sept. 11, 1902. No. 50770 G.

The Electrolytic Production of Chlorine and Alkalis by the Solvay-Kellner Process (Ueber Elektrolytische Gewinnung von Chlor und Alkali nach dem Solvay-Kellnerschen Quecksilber-Prozess). F. Glaser. A cathode of quicksilver and an anode of platin-iridium are used. 2500 w. Zeitschr f Elektrochemie—Aug. 7, 1902. No. 50769 G.

Aluminum.

The Production of Aluminum (Ueber Aluminumdarstellung). Dr. F. Haber. An examination of the electrolytic reduction of aluminum from fused salts by the direct action of the electric arc in a carbon crucible. 4500 w. Zeitschr f Elektrochemie—Aug. 21, 1902. No. 50771 G.

Bisulphide of Carbon.

The Manufacture of the Bisulphide of Carbon in the Electric Furnace. Edward R. Taylor. Read at meeting of the Am. Electro-Chem. Soc. Describes the electrical process developed by the writer which has proved highly satisfactory. 1000 w. Sci Am Sup—Sept. 13, 1902. No. 50492.

Convention.

Convention of the American Electro-Chemical Society. A report of the meeting at Niagara Falls, with abstracts of papers presented. 7700 w. Eng News—Sept. 25, 1902. No. 50672.

Electric Smelting.

The Ruthenberg Electric Iron Process. Marcus Ruthenberg. Extract from a pa-

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per presented to the Am. Electro-Chem. Soc. describing the author's method of fusing fine concentrates by the electric arc, into lumps suitable for the flash furnace. 1200 w. Ir Age—Sept. 25, 1902. No. 50667.

Iron Protection.

Electrogalvanizing. C. F. Burgess and Carl Hambulchen. Discusses the electrolytic deposition of zinc as a protective coating on structural iron, its characteristics, cost, process, etc. 7200 w. Elec Wld & Engr—Sept. 13, 1902. No. 50547.

Nitrogen.

Fixing Nitrogen from the Atmosphere. T. C. Martin. A description of the apparatus of Bradley, in operation at Niagara Falls by which atmospheric nitrogen is converted into nitric acid by the action of electric arcs, for the manufacture of nitrates. 2300 w. Rev of Revs—Sept., 1902. No. 50328 C.

Ozone.

See Civil Engineering, Water Supply.

Precious Stones.

Formation of the Diamond by the Electric Furnace. An illustrated description of the process used by M. Moissan, giving the results attained. 1500 w. Sci Am—Aug. 30, 1902. No. 50243.

Slimes.

See Mining and Metallurgy, Gold and Silver.

ELECTRO-PHYSICS.

Alternating Currents.

The Alternating Current Arc. C. H. Bedell. An illustrated article considering the behavior of the alternating arc when in a magnetic field. 700 w. Elec Wld & Engr—Sept. 13, 1902. No. 50545.

Earth Currents.

Atmospheric Electricity and Earth Currents. E. O. Walker. Reviews the opinions of various experimenters and gives an account of the writer's investigations. 2000 w. Elect'n, Lond—Sept. 12, 1902. No. 50625 A.

Electric Waves.

On Electromotive Wave Accompanying Mechanical Disturbance in Metals in Contact with Electrolyte. Prof. J. Chunder Bose. The full paper presented before the Royal Society upon "Response in Organic Substances," showing electromotive effects produced by molecular disturbance. Two articles, 4500 w. Elect'n, Lond—Aug. 29, Sept. 5. 1902, No. 50463, each A.

Electromagnetism.

Rational Electromagnetic Units. A paper contributed to the Physical Society of London, by Signor Giovanni Giorgi, explaining his system which has been recommended for adoption by a committee of an Italian Congress. 3500 w. Elec Wld & Engr—Sept. 6, 1902. No. 50443.

Furnace.

Electric Furnace for Laboratory Work (Fours à Chauffage Electrique pour Laboratoires). Léon Guillet. Illustrating and describing the Heraeus furnace in practical use for high-temperature laboratory investigations. 1500 w. Génie Civil —Aug. 30, 1902. No. 50725 D.

Magnetism.

The Magnetic Properties of Iron and Steel at Liquid Air Temperatures. C. C. Trowbridge. A brief account of investigations of this subject, giving the results obtained. Also editorial. 4000 w. Elec Wld & Engr—Aug. 30, 1902. No. 50278.

Radiography.

Becquerel Rays and Radioactive Substances (Ueber Becquerelstrahlen und die Radioaktiven Substanzen). Dr. F. Giesel. A review of the discoveries which have been made in radio-activity, with theories as to the source of the emitted energy. 2500 w. Zeitschr f Elektrochemie—Aug. 14, 1902. No. 50772 G.

GENERATING STATIONS.

Accumulators.

See Electrical Engineering, Electro-Chemistry.

Armatures.

Armature Core Discs for Continuous-Current Machines. Fred W. Davies. Notes and formulae intended for assistance in designing a suitable core disc. Ill. 3000 w. Elec Rev, Lond—Aug 22, 1902. No. 50352 A.

The Heating of Toothed-Core Armatures. Fred W. Davies. Considers some of the causes of overheating. 1500 w. Elect'n, Lond—Sept. 12, 1902. No. 50626 A.

Boston, Mass.

The Power Plants Which Light Boston. Describes and illustrates the Atlantic Avenue, and the South Boston stations. The former supplies direct current, and the latter the street lighting circuits and alternating current. 9800 w. Engr, U S A—Sept. 1, 1902. No. 50281.

Collectors.

The Arrangement of Commutators and Collecting Rings (Behandlung von Kollekforen und Schleifringen). R. Hellmund. A discussion of the best arrangement of brushes and collecting and commutating rings for dynamos, with diagrams showing the effect of lubrication. 2500 w. Elektrotech Zeitschr—Sept. 11, 1902. No. 50766 B.

Dynamo.

The Déri Compensated Direct-Current Dynamo (Ueber Kompensirte Gleich-

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strommaschinen, System Déri). Frederick Eichberg. A description of the Déri system of winding by which a constant potential is secured in direct-current generators. 6000 w. Elektrotech Zeitschr—Sept. 11, 1902. No. 50765 B.

Electric Plant.

Electric Power, Light and Electric Welding Installation at the New Pimlico Wheel Works. Illustrated description. 3000 w. Elec Rev, Lond—Sept. 12, 1902. No. 50621 A.

Generating Sets.

Testing of Combined Steam-Engine and Dynamo Sets. Extracts from a paper presented to the Inst. of Civ. Engrs. by Edwin Hartree Rayner. An outline by the tests usually applied to such sets and the methods used in the testing shops of engine makers. Also editorial. 4000 w. Eng Rec—Sept. 6, 1902. No. 50447.

Hydro-Electric Plants.

A Low-Head Water-Power Plant at Fumay, France. From *Le Genie Civil.* Illustrates and describes the power plant of a factory which consists of water power, supplemented when necessary by a steam plant and all connected on an electric system of distribution. 1000 w. Eng Rec—Aug. 30, 1902. No. 50317.

The Hydro-Electric Station at Hagneck. Enrico Bignami. An illustrated description of an interesting Swiss water-power installation, the difficulties overcome, etc. 4300 w. Elec Rev, N Y—Sept. 13, 1902. No. 50538.

The Largest Hydro-Electrical Plant in Europe. From the *Illustrirte Zeitung.* An illustrated description of the water power of the Tessin, in Lombardy. 1000 w. Sci Am Sup—Aug. 30, 1902. No. 50246.

The Largest Electric Water Power Station in New England. Illustrates and describes the system of the Lewiston and Auburn Co., on the Androscoggin River, Maine, and its proposed extensions. 1900 w. Elec Wld & Engr—Sept. 20, 1902. No. 50652.

The Snoqualmie Falls Power Plant. Enos Brown. Illustrations and brief description of this remarkable plant in Washington. 1600 w. Sci Am—Aug. 30, 1902. No. 50241.

The Water Power Plant of the Michigan-Lake Superior Power Co., at Sault Ste. Marie. Views and particulars relating to this recently completed plant. 2200 w. Eng News—Sept. 25, 1902. No. 50671.

Water Power Transmission for the Springfield, Mass., Lighting System. Illustrates and describes the station at Birchem Bend. 1200 w. Elec Wld & Engr—Sept. 6, 1902. No. 50441.

Incomes.

Incomes of Electric Stations. Alton D. Adams. An investigation of the incomes for service to commercial arc lamps, commercial incandescent lamps, electric motors and arc and incandescent street lamps, as based on the reports from stations in Massachusetts. 3800 w. Elec Rev, N Y—Sept. 13, 1902. No. 50537.

Isolated Plant.

The Power Plant of B. F. Keith's Theater, Boston. Describes the main features of the lighting, heating and ventilating plant, and the unusually fine equipment of this public building. Ill. 4000 w. Engr, U S A—Sept. 1, 1902. No. 50282.

Lagos.

The Electric Station at Lagos (Die Elektrische Centrale in Lagos). C. Hohl. A general description of the modern generating station for lighting, power and tramway service, in the capital of British West Africa. 3000 w. Elektrotech Zeitschr—Aug. 21, 1902. No. 50758 B.

Parallel Driving.

Parallel Operation of Direct-Connected Alternators. P. C. Oscanyan. Describes investigations made by the writer of the pendulum action which sometimes causes the generators to go out of step. 1200 w. Elec Wld & Engr—Sept. 13, 1902. No. 50548.

Engine Governing and Parallel Running of Alternators. Abstract of report of a special committee of the International Soc. of Elec. Engrs. on the best method of running alternators in parallel. 1500 w. Eng Rec—Sept. 20, 1902. No. 50645.

Phase Displacement.

A Simple Demonstration of Phase Displacement in Alternating Circuits (Ein fache Demonstration der Phasenverschiebung in Wechselstromkreise). W. Kohlrausch. Describing a mechanical model by means of which phase displacement may be given ocular demonstration. 1200 w. Elektrotech Zeitschr—Sept. 11, 1902. No. 50767 B.

Power Stations.

See Street Railways and Tramways.

Sunderland.

Sunderland Electricity Works. Notes and illustrations descriptive of this station and the extensive work recently carried out. 3000 w. Elec Engr, Lond—Sept. 12, 1902. No. 50614 A.

Switchgears.

Future Types of Switchgears. W. E. Warrilow. Describes recent types in American and Continental stations, commending the cellular type of gear. 2000 w. Elec Engr, Lond—Sept. 5. 1902. No. 50612 A.

We supply copies of these articles. See page 325.

Three Phase.

Three-Phase Power Plant in a Welsh Lead Mine. Illustrated description of the plant in the Frongoch mine, in Cardiganshire. 700 w. Elec Rev, Lond—Sept. 12, 1902. No. 50619 A.

Transformers.

Testing the Efficiency of Transformers. Fred W. Ballard. Gives directions for testing for core losses, copper losses, etc. Ill. 1800 w. Engr, U S A—Sept. 15, 1902. No. 50664.

The Station Transformer Hazard. George P. Low. Abstract of a paper read before the Fire Underwriters' Assn. of the Pacific. Considers the practice of immersing the transformer in oil and the dangers arising, suggesting their elimination by the confinement of the transformers in separate fire-proof buildings. 1600 w. Jour of Elec—Aug., 1902. No. 50254.

LIGHTING.

Address.

The Scope of Lighting Technology (Die Ziele der Leuchttechnik). Otto Lummer. Addresses delivered before the Elektrotechnischen Verein in Berlin, reviewing in an exhaustive manner the subject of artificial illumination, with especial reference to electric lighting. An extensive bibliography is appended. Two articles; 20000 w. Elektrotech Zeitschr—Aug. 28, Sept. 4, 1902. No. 50763 each B.

Arc Lighting.

Development of Arc Lighting Apparatus from 1810 to 1902. W. D'A. Ryan. Read before the Canadian Elec. Assn. An illustrated review of the most important points in the development of arc lamps. 2800 w. Can Elec News—Sept., 1902. No. 50483.

Nernst Lamp.

Experience with the Nernst Lamp. Extracts from the discussion at the recent Cincinnati Electric Light convention on this subject. 4300 w. Am Elect'n—Sept., 1902. No. 50481.

New South Wales.

Electric Lighting in Sydney. Brief illustrated description of the Empire Company's station. 1500 w. Aust Min Stand —Aug. 14, 1902. No. 50607 B.

Pioneers.

Staite and Petrie's Electric Light—1846 —1853. J. J. Fahie. An illustrated article giving an account of the labor of two early workers in this field and what they accomplished. Also editorial. 4800 w. Elec Engr, Lond—Aug. 29, 1902. Serial. 1st part. No. 50458 A.

MEASUREMENT.

Alternating Currents.

The Measurement of Power in Alternating Current Circuits. W. G. Rhodes. An explanation of methods of deducing formulae for the measurement of power in alternating current circuits without having recourse to the calculus. 600 w. Elec Rev, Lond—Sept. 5, 1902. No. 50563 A.

Materials.

Rules for the Construction and Testing of Installation Material (Vorschriften für die Konstruktion und Prüfung von Installationsmaterial). The provisional rules of the Verband Deutscher Elektrotechniker, to be given a trial for one year. 2000 w. Elektrotech Zeitschr—Aug. 21, 1902. No. 50759 B.

Meter.

A New Alternating-Current Meter (Ein Neuer Wechselstromzähler). Georg Stern. The new meter of the Union Elektrizitäts-Gesellschaft, of the induction motor type, is described in detail, together with method of calibrating. 4500 w. Elektrotech Zeitschr—Aug. 28, 1902. No. 50762 B.

Oscillograph.

Blondel Oscillograph—New 1902 Type. C. L. Durand. Illustrated description of an instrument for observing all kinds of varying electrical phenomena. 2000 w. Elec Rev, N Y—Sept. 13, 1902. No. 50540.

Potentiometer.

Checking Electrical Instruments. Dr. Clayton H. Sharp. Abstract of a paper read at the Mt. Washington convention of the Edison Illuminating Companies. Describes methods of measurement with the potentiometer, used with a standard cell. 1800 w. Elec Wld & Engr—Sept. 20, 1902. No. 50654.

Standards.

Standards for Electrical Generators and Transformers (Normalien für Elektrische Maschinen und Transformatoren). The provisional standards of the Verband Deutscher Elektrotechniker, which have been under trial for the past year and are to be given another year's trial. 4000 w. Elektrotech Zeitschr—Aug. 21, 1902. No. 50760 B.

Testing.

See Electrical Engineering, Generating Stations.

Transformers.

A Practical Method of Calculating Transformer Reactance. Presents a simple method of arriving at a basis from which the short circuit reactance of transformers of ordinary commercial design may be accurately predicted. 1000 w. Elec Rev, Lond—Sept. 5, 1902. No. 50562 A.

POWER APPLICATIONS.

Canal Haulage.

Electrically-Operated Canals in Belgian Coal Mining Districts. Frank C. Per-

kins. Illustrates and describes the operation of the Charleroi Canal in Belgium, and reports the progress in electric propulsion generally. 1000 w. Marine Engng —Sept., 1902. No. 50300 C.

Cement Works.

The Pacific Portland Cement Company's Works. Watson Vredenburgh, Jr. Illustrated detailed description of a hillside plant in California. The power is electrical, and the fuel for the burning and driving is obtained from the Caifornia oil fields. 2200 w. Eng Rec—Aug. 30, 1902. No. 50316.

Coal Cutting.

Electric Coal-Cutting Plant at the Lambton Collieries Co., Durham. An account of a visit of the N. of Eng. Inst. of Min. Engrs. to these collieries, with description of interesting methods observed. 2500 w. Col Guard—Sept. 12, 1902. No. 50639 A.

Comstock Lode.

Recent Application of Electrical Power on the Comstock Lode. Leon M. Hall. Read at the convention of the Pacific Coast Elec. Trans. Assn. Illustrates and describes the most important features of the new installation. 4700 w. Jour of Elec—Aug., 1902. No. 50252.

Cranes.

Electric Cranes. Waldon Fawcett. Illustrates and describes various types. 2400 w. Elec Rev, N Y—Sept. 13, 1902. No. 50541.

Sixty-ton Electric Traveling Crane (Pont Roulant Electrique de Soixante Tonnes). Ch. Dantin. Illustrated description of an electric traveling crane of 30 metres span, and 60 metric tons capacity, at the Chaussade steel works, at Guérigny, France. 1500 w. 1 plate. Génie Civil—Aug. 16, 1902. No. 50719 D.

Direct-Current.

The Up-Keep of the Direct Current Motor and Its Accessories. Alfred H. Mayes. Considers the causes of trouble to which a motor is liable, and the precautions to be taken. 2000 w. Elec Rev, Lond—Sept. 12, 1902. No. 50616 A.

Drilling.

Electrical Tests of Power Required for Drilling Cast Iron from the Solid. Data obtained in a series of tests to determine the power required to operate drilling machines with different sizes of drills. 1000 w. Am Mach—Sept. 18, 1902. No. 50585.

Drying Oven.

An Improved Drying Oven. Edmund S. Smith. Brief illustrated description of an electric oven, simple and easily constructed. 600 w. Sci Am—Sept. 20, 1902. No. 50599.

Gas Works.

Electrically Operated Appliances in Gas and Electric Works. George C. Holberton. Read before the Pacific Coast Gas Assn. Illustrated description of electrical appliances found useful in gas works, with remarks on their convenience, economy, etc. 2500 w. Am Gas Lgt Jour—Sept. 22, 1902. No. 50658.

Hoisting.

The Influence of Electricity upon the Development of Hoisting Machinery (Die Lastenförderung unter dem Einfluss der Elektrotechnik). H. Kammerer. A general discussion of the adaptability of the electric motor to hoisting machinery, and the modifications which have resulted from its use. 3500 w. Zeitschr d Ver Deutscher Ing—Sept. 13, 1902. No. 50575 D.

Machine Driving.

An Electrically Operated Manufacturing Plant. Illustrated description of the displacement of steam by electricity as motive power in the Lister Agricultural Chemical Works at Newark, N. J. 3000 w. Am Elect'n—Sept., 1902. No. 50480.

Electricity as a Motive Power for Machine Shops. With special reference to the electrical equipment of the William R. Trigg Co., Richmond, Va., which is illustrated and described. 4800 w. Mach, N Y—Sept., 1902. No. 50384.

Electric Power in Iron Works (Emploi de l'Electricité dans le Forges). A. Abraham. With especial reference to the use of electric driving in forges and rolling mills, with examples from French and German practice. 3000 w. Génie Civil—Aug. 30, 1902. No. 50723 D.

Power, Lighting and Heating at the Du Bois Shops of the Buffalo, Rochester & Pittsburg Ry. Illustrated description of an electric and compressed air system of power transmission, with power, lighting, compressed air and heating all served from a central station. 2500 w. Eng Rec —Sept. 6, 1902. No. 50444.

The Electrical Driving of Machinery; Its Economy and Advantages. Frank Broadbent. A discussion of this subject illustrated by examples. 2800 w. Elec Rev, Lond—Sept. 12, 1902. No. 50615 A.

The Power Equipment of the Westinghouse Works at Trafford Park. A brief general description with illustrations. 1800 w. Elec Rev, Lond—Sept. 12, 1902. No. 50618 A.

Mining Plant.

Electric Plant in the Grand Duke Frederick Iron Mine at Zakarfalu, Hungary (Die Elektrischen Anlagen des Erzherzoglich Friederich'schen Eisensteinbergbaues in Zakarfalu). H. Drolz. A description of the utilization of the water

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power of the Gölnitz for the light and power plant of the mines at Zakarfalu, including the transport of iron ore to the railway, 5 kilometres distant. Serial. Part I. 2 plates. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 16, 1902. No. 50738 B.

Kalgoorlie Electric Power. C. E. Crocker. A description of this plant the principal purpose of which is to supply electric current to the mines. 1700 w. Aust Min Stand—July 17, 1902. No. 50331 B.

The Kalgoorlie Electric Power and Lighting System. Illustrated description of the first large power distribution scheme in Australia, which furnishes over 15,000 H. P. for these gold mines. 1800 w. Elec Rev, Lond—Sept. 12, 1902. No. 50620 A.

Motor Losses.

Losses in a Large Non-Synchronous Motor (Ueber Verluste an einem Grossen Asynchronmotor). F. Bodensteiner. Data and results of a test of a Siemens & Halske motor of 170 h. p.; showing an efficiency of 92.4 per cent. at full load. 1200 w. Elektrotech Zeitschr—Aug. 21, 1902. No. 50757 B.

Motors.

A New Method of Starting Induction Motors (Ein Neues Verfahren zum Anlassen von Induktionsmotoren). Alfred Schwartz. An examination of the operation of the induction motor and the condition of starting under load. A centrifugally operated clutch throws the load on only when full speed is attained. 4000 w. Elektrotech Zeitschr—Sept. 4, 1902. No. 50764 B.

Electric Motors. Definitions and Functions. F. J. A. Matthews. Explains the function of the various parts of the dynamos, and the definition of some of the commoner terms used. 3800 w. Mech Engr—Aug. 23, 1902. Serial. 1st part. No. 50337 A.

Ore Handling.

Electricity in Ore Handling. Waldon Fawcett. Describes the application of electricity to this work, especially in loading and unloading. Ill. 1500 w. Am Mfr —Aug. 28, 1902. No. 50290.

Storage Batteries.

Storage Batteries in Mills and Factories. E. Vail Stebbins. Describes the construction of a battery and its action, and the extent to which storage batteries may be put in mills and factories to equalize the load. Ill. 4500 w. Jour Assn of Engng Soc's—July. 1902. No. 50322 C.

TRANSMISSION.

Canada.

The Largest Electrical Transmission in Canada. Alton D. Adams. Illustrated description of the plant of the Hamilton Electric Light and Cataract Power Company. 1200 w. Elec Rev, N Y—Aug. 30, 1902. No. 50255.

High-Tension.

Pressure Rise in High-Tension Transmission. W. B. Woodhouse. Considers the causes of excessive pressure rise and the means of safeguarding the system against undue stress. 1600 w. Elect'n, Lond—Sept. 5, 1902. No. 50559 A.

Lines.

Construction of Transmission Lines. A portion of a paper by George H. Lukes read at the recent convention of the Edison Illuminating Companies. Treats of line construction, switching, regulation and rates. 3000 w. Elec Wld & Engr—Sept. 20, 1902. No. 50655.

Long Distance.

Commercial Success in Long-Distance Electric Power Transmission. Extract from the Presidential address of Dr. Chas. W. Van Norden, before the Pacific Coast Elec. Trans. Assn. 1200 w. Eng News—Sept. 4, 1902. No. 50399.

Long Distance Power Transmission. F. A. C. Perrine. A study of some of the problems to be solved in securing continuity and regulation. 5000 w. Sci Am Sup—Sept. 13, 1902. No. 50493.

The Physical Limits of Electric-Power Transmission. Alton D. Adams. A discussion of the possibilities of high voltages and the methods required in apparatus and line for long-distance power transmission. 3000 w. Engineering Magazine—October, 1902. No. 50782 B.

Pike's Peak.

The Pike's Peak Power Transmission. R. M. Jones. Illustrated description. 3500 w. Jour of Elec—Sept., 1902. No. 50695.

MISCELLANY.

Agriculture.

The Relations of Agriculture to Electrotechnics (Was Hat die Elektrotechnik von der Landwirthschaft zu Erwarten). Dr. Robert Haas. A discussion of the possibilities of the application of electricity to agricultural districts, especially in connection with the distribution of light and power. 4500 w. Elektrotech Zeitschr—Aug. 28, 1902. No. 50761 B.

Statistics.

Statistics of Electrical Progress. Reviewing the report prepared by Thomas Commerford Martin on the manufacture of electrical apparatus and supplies. 1800 w. Elec Rev, N Y—Sept. 6, 1902. No. 50390.

U. S. Census Report on Electrical Manufactures. A review of the report compiled by Mr. T. C. Martin, giving tabulated information and discussing the report in general. 5000 w. Elec Wld & Engr—Sept. 20, 1902. No. 50653.

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GAS WORKS ENGINEERING

Birmingham, Eng.

The Windsor Street (Birmingham) Gas-Works and the New Coke Plant. On the methods introduced at this plant with an illustrated description of the new coke conveyor. 1400 w. Jour Gas Lgt—Sept. 9, 1902. No. 50577 A.

Comparisons.

Relative Attractiveness of Different Artificial Lights. Reviews the improvements in artificial lighting. especially as affecting England. 2500 w. Jour Gas Lgt—Aug. 19, 1902. No. 50354 A.

Engineers.

The Rise and Recognition of the Engineer, with Especial Reference to Gas Engineering. L. P. Lowe. Read at meeting of the Pacific Coast Gas Assn. 3200 w. Am Gas Lgt Jour—Sept. 22, 1902. No. 50657.

Gas Power.

See Mechanical Engineering, Special Motors.

Gas Stoves.

Gas-Cookers—Desirable to Gas Companies and Consumers. D. W. Lyme. Read before the Irish Assn. of Gas Mgrs. Concerning increasing the sale of gas through the medium of gas-cookers. Also discussion. 3000 w. Jour Gas Lgt—Aug. 26, 1902. No. 50341 A.

The Housing of the Gas Cooking Stove. Norton H. Humphreys. Suggesting the placing of these stoves in a place prepared for them, with a ventilating flue to carry off the steam and products of combustion. 2200 w. Jour Gas Lgt—Sept. 9, 1902. No. 50578 A.

Gas Works.

See Electrical Engineering, Power Applications.

Ireland.

Gas Affairs in the West of Ireland. T. J. Reid. Read before the Irish Assn. of Gas Mgrs. An account of the conditions prevailing, and what has been done to modernize some of the works. Discussion. 6400 w. Gas Wld—Aug. 23, 1902. No. 50347 A.

Leakage.

Gas Leakage in American Cities. James C. Bayles. Considers the economic and hygienic aspects, and how to remedy the evil. Ill. 5000 w. Munic Jour & Engr—Sept., 1902. No. 50293 C.

Meters.

The Prepayment Meter System in Sligo. C. B. Tully. Read before the Irish Assn. of Gas Mgrs. Describes the satisfactory introduction of these meters. Discussion. 2200 w. Gas Wld—Aug. 23, 1902. No. 50348 A.

Mill Lighting.

Incandescent Gas Lighting in Mills. Presidential address of Mr. Laurence Bell, before the Waverly Assn. of Gas Mgrs. Discusses the difficulties to overcome and how they may be conquered, and related matters. 2000 w. Gas Wld—Sept. 13, 1902. No. 50611 A.

Municipal Plants.

Cost of Light in Municipal and Private Gas and Electric Plants. Alton D. Adams. A comparison between two groups of towns in Massachusetts as to the price of gas to private consumers, the cost of electric street lighting, and the net earnings on the invested capital. In one group the plants are owned by private corporations, in the other by the municipality. 900 w. Munic Engng—Sept., 1902. No. 50330 C.

Photometry.

Effect of Varying the Conditions of Combustion on the Illuminating Power of Coal Gas. H. Leicester Greville. Gives tabulated results of investigations of the light of different grades of coal gas under varying conditions to determine the best method of developing the maximum light. 800 w. Jour Gas Lgt—Aug. 19, 1902. No. 50355 A.

The History of English Photometry. Vivian B. Lewes, in *Il Gaz.* A sketch of the history during the last 200 years. 6000 w. Gas Wld—Sept. 6, 1902. No. 50556 A.

Purification.

An Experiment on the Principles of Purification. E. C. Jones. Read before the Pacific Coast Assn. Also discussion. Describes experiments with two types of purifiers, giving results. Ill. 4500 w. Am Gas Lgt Jour—Sept. 8, 1902. No. 50420.

Retorts.

Inclined Retorts. E. Merz. Abstract translation of a paper read before the German Gas Assn. Deals with the objections raised against inclined retorts, showing them unfounded. 1200 w. Gas Wld—Sept. 6, 1902. No. 50557 A.

Sulphate.

Sulphate Manufacture in Great Britain. Extracts from the report of R. Forbes Carpenter to the Local Government Board, showing the production from the gas in-

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dustry, and matters relating. 3000 w. Gas Wld—Aug. 30, 1902. No. 50456 A.

Sulphuretted Hydrogen.

Estimation of Sulphuretted Hydrogen in Minute Quantities in Coal Gas. W. J. Dibdin. Read before the Soc. of Public Analysts. Describes methods used and results obtained. Also discussion. 1800 w. Jour Gas Lgt—Sept. 9, 1902. No. 50579 A.

The Action of Ferrous Thiosulphate on Sulphuretted Hydrogen. An account of experiments carried out by Mr. Linder and given in report of R. Forbes Carpenter. 2000 w. Jour Gas Lgt—Sept. 2, 1902. No. 50466 A.

Water Gas.

Dellwik-Fleischer Water-Gas Plant at Nuremberg. From the *Journal für Gasbeleuchtung*. Particulars concerning this plant. 2000 w. Jour Gas Lgt—Aug. 19, 1902. No. 50356 A.

INDUSTRIAL ECONOMY

Address.

Prof. James Dewar's Presidential Address to the British Association. Abstract. Discusses education, the importance of science, the value of applied chemistry, etc. 5200 w. Elect'n, Lond—Sept. 12, 1902. Serial. 1st part. No. 50624 A.

American Workmen.

Fifty Years Among American Workingmen. Egbert F. Watson. Observations from the writer's experience, describing the social and material condition of fifty years ago, the workmen, the effect of increased immigration, development, etc. 4000 w. Ir Age—Sept. 18, 1902. No. 50549.

Bonus System.

The Bonus System of Rewarding Labor. H. L. Gantt. Explains the work of Mr. Fred W. Taylor, as this system was an outgrowth from his investigations, showing the advantages and the working of the system. 2000 w. Rev of Revs—Sept, 1902. No. 50326 C.

Commerce.

Problems of the Pacific—The Commerce of the Great Ocean. O. P. Austin. Shows reasons why the United States will always possess exceptional facilities for commerce with the countries touched by the Pacific Ocean. Ill. 6000 w. Nat Geog Mag—Aug., 1902. No. 50288 C.

Competition.

The Competition of the United States (Der Wettbewerb der Vereinigten Staaten). H. Schwabe. A review of the development of the iron and steel industries of the United States, showing the influence of its competition upon German trade. 3000 w. Glasers Annalen—Sept. 1, 1902. No. 50717 D.

Contracts.

Separate *versus* General Contracts. Informal discussion of whether in contract work, either public or private, it is preferable to make contracts for the different branches of trade involved, or to combine all under one general contract. 6000 w. Pro Am Soc of Civ Egrs—Aug., 1902. No. 50429 E.

Cost-Keeping.

Co-operative and Mechanical Aids to Work-Shop Cost-Keeping. R. P. Link. Read before the Inst. in Sunderland. Calls attention to the method of utilizing automatic machines to control the keeping of costs in shops. Also discussion. 4800 w. Trans of N E Coast Inst of Engrs & Shipbldrs—July, 1902. No. 50340 D.

Unit Costs of Work in Progress. Informal discussion of whether it is possible and desirable to keep accounts of cost of work in such a manner as to ascertain unit costs on each class of work. 3300 w. Pro Am Soc of Civ Engrs—Aug., 1902. No. 50430 E.

The Cost-Keeping Systems of an Ohio Jobbing Foundry. Outlines the system used in a foundry employing a large force of workmen on a great variety of work. 1200 w. Ir Trd Rev—Sept. 4, 1902. No. 50382.

Düsseldorf Exposition.

Salient Features of the Düsseldorf Exposition. Harrington Emerson. A richly illustrated account of the Rhenish-Westphalian exposition at Düsseldorf as indicating Germanv's progress in engineering and metallurgy. 4000 w. Engineering Magazine—October, 1902. No. 50783 B.

The Düsseldorf Exposition of 1902 (L'Exposition Régionale de Düsseldorf en 1902). P. Dujardin. A general review of the Düsseldorf exposition from a French point of view. 2500 w. Génie Civil—Aug. 16, 1902. No. 50718 D.

See also Mining and Metallurgy.
See also Railway Engineering.

Education.

New Powers and New Responsibilities (Neue Rechte—Neue Pflichten). W. v. Oechelhaeuser. The Presidential address before the Düsseldorf meeting of the Verein Deutscher Ingenieure, dealing with problems of engineering education. 5000 w. Zeitschr d Ver Deutscher Ing—Aug. 23, 1902. No. 50707 D.

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Prof. John Perry's Presidential Address Before Section G of the British Association. Discusses the subject of education especially as applied to engineering. 5000 w. Elect'n, Lond—Sept. 12, 1902. Serial. 1st part. No. 50627 A.

Iron Industry.

The Foundations of the American Iron Industry. Archer Brown. A critical review of the causes, conditions and probable duration of the present era of prosperity in the American Iron Trade. 4000 w. Engineering Magazine—October, 1902. No. 50781 B.

Irrigation.

Irrigation Works. Informal discussion of the question whether the National Government should undertake the construction and operation of irrigation works. 9800 w. Pro Am Soc of Civ Engrs—Aug., 1902. No. 50433 E.

Labor.

The Shop Clubs Act, 1902. Editorial discussion of an act recently passed which places further statutory restrictions upon the liberty of employers in dealing with their men. 1400 w. Engng—Aug. 29, 1902. No. 50472 A.

Wages and Hours of Labor in 1901. Review of the last annual report of the Labor Department of the Board of Trade in England. 2500 w. Engng—Sept. 5, 1902. No. 50573 A.

Locomotive Trade.

Competition for the Foreign Locomotive Trade. Extracts from a correspondence between the Secretary of State for India and certain British firms as to competition between German and British builders of locomotives. 3300 w. R R Gaz—Aug. 29, 1902. No. 50271.

Municipal Ownership.

Municipal Trading. Robert P. Porter. Read at Belfast meeting of the Brit. Assn. for the Adv. of Science. Discusses this subject as related to English methods, giving the history of the same industries as carried on in the United States, and considering the objections to municipal trading as carried on in England. 6000 w. Engng—Sept. 19, 1902. No. 50817 A.

Shop Records.

Workshop Records. A Review and Comparison of Existing Methods, with Special Reference to the Use of Cards and Files Instead of Books. George Parker. Read before the meeting in South Shields. Also discussion and 2 plates. 13400 w. Trans of N E Coast Inst of Engrs & Shipbldrs—July, 1902. No. 50339 D.

South Africa.

South Africa from an Engineer's Point of View. The present article is a review of some recent investigations by a general trade commission. 900 w. Engr, Lond—Sept. 5, 1902. Serial. 1st part. No. 50565 A.

Statistics.

The Census of Manufactures. S. N. D. North. Information concerning the cost and work of preparing valuable statistics in the industries, and a review of the more important facts of this latest census of manufactures. 4200 w. Rev of Revs—Sept., 1902. No. 50325 C.

Stream Control.

See Mechanical Engineering, Hydraulics.

Strikes.

Is the Coal Strike a Conspiracy? Discussion of the anthracite coal strike, especially the attitude of the operators. 2000 w. Gunton's Mag—Sept., 1902. No. 50287.

Tariff.

The Iron Tariff in the First Reading of the Tariff Commission (Die Eisenzölle in der I Lesung der Zolltarifcommission). The full tabular changes proposed in the German tariff on iron; with editorial comments. 3000 w. Stahl u Eisen—Aug. 15, 1902. No. 50748 D.

Technical Dictionary.

The Technolexicon (Technolexikon). The progress report of the editor, Dr. Hubert Jansen upon the new technical dictionary in English, French and German, now being prepared by the Society of German Engineers. 6000 w. Zeitschr d Ver Deutscher Ing—Aug. 30, 1902. No. 50711 D.

Works Management.

Money-Making Management for Workshop and Factory. Charles U. Carpenter. Mr. Carpenter's concluding paper is devoted to the finding and recording of costs, and to a general summary of the whole series. 4000 w. Engineering Magazine—October, 1902. No. 50787 B.

MARINE AND NAVAL ENGINEERING

Battleship.

Laying the Keel of the New Battleship "Nebraska" at the Works of Moran Bros. Company, Seattle, Wash. July 4, 1902. An illustrated article more particularly describing the plant where this vessel is under construction. 1500 w. Sci Am Sup—Aug. 30, 1902. No. 50244.

The French Battleship Republique. Illustrated description of one of six new battleships which are building or projected, showing a change in French shipbuilding

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policy. Also editorial. 2500 w. Engr, Lond—Sept. 12, 1902. No. 50632 A.

United States Battleships Connecticut and Louisiana. Describes and illustrates these recently authorized vessels and their equipment. 2500 w. Engr, Lond—Aug. 29, 1902. No. 50474 A.

Bearings.

Roller Bearings for Marine Engines. Stephen P. M. Tasker. Discusses the advantages, and reports the test made of the steam yacht "Sagamore." 800 w. Marine Engng—Sept., 1902. No. 50302 C.

Clyde Works.

Clyde Trust New Works. A description of new works in progress and new features recently introduced. 2500 w. Engr, Lond—Sept. 12, 1902. No. 50633 A.

Destroyer.

The Swedish Torpedo Boat Destroyer "Mode." Illustrated description of a fine boat, recently completed, with report of the official trial. 800 w. Engng—Sept. 19, 1902. No. 50815 A.

Fast Vessels.

On the Strength of High-Speed Vessels. M. J. A. Normand. Considers some of the causes producing fatigue that are often overlooked. 2300 w. Engng—Sept. 12, 1902. No. 50637 A.

Lake Steamers.

Notable New American Lake Steamboats. Illustrated description of the two latest passenger boats for the Great Lakes, the "Western States" and the "Eastern States." 1000 w. Naut Gaz—Aug. 28, 1902. No. 50247.

Launch.

Hospital Electric Launch. Illustration and description of a novel vessel to be used for the St. John's Guild, New York, for transferring sick children between the floating hospitals and the Seaside Hospital. 600 w. Marine Engng—Sept., 1902. No. 50305 C.

Launching.

The Launch of the Twin-Screw Steamer Kaiser Wilhelm II. (Der Stapellauf des Doppelschrauben-Schnelldampfers "Kaiser Wilhelm II.") Description of the launch, with details of the dimensions of the vessel, the longest yet built, being 706 feet in length. 1500 w. 2 plates. Zeitschr d Ver Deutscher Ing—Aug. 16, 1902. No. 50700D.

Life Boat.

The Carley Life Float. Illustration with description of a device for saving life at sea. 900 w. Am Shipbuilder—Sept. 11, 1902. No. 50477.

Liners.

Modern Ocean Liners. Editorial on the present position of England in this field, especially comparing it with Germany. 2700 w. Engng—Aug. 22, 1902. No. 50371A

Naval Engineers.

The Engineering Branch of the Royal Navy. Editorial review of a printed statement of the causes of dissatisfaction and proposed remedies. 3700 w. Engng—Aug. 29, 1902. No. 50471 A.

Naval Manoeuvres.

The French Naval Manoeuvres. An account of the manoeuvres carried out by the French fleets in the Mediterranean during the past month which were of more than usual interest. 4000 w. Engr, Lond—Aug. 22, 1902. No. 50360 A.

The French Naval Manoeuvres. Editorial review of this year's manoeuvres which were on an exceptionally large basis. 2800 w. Engng—Sept. 12, 1902. Serial. 1st part. No. 50634 A.

Ocean Tramps.

Lake-Built Ocean Tramps. Theodore Lucas. Considers the limitations of ships to be built on the lakes for ocean service and their effect on the earning possibilities of cargo steamers. 2000 w. Naut Gaz—Aug. 28, 1902. No. 50248.

Oil Fuel.

Report of Recent Oil Burning Installations on the Pacific Coast. Edward S. Hough and William H. Crawford, Jr. Gives illustrations showing the experience gained in marine work at the port of San Francisco. Ill. 2200 w. Marine Engng—Sept., 1902. No. 50301 C.

Oil Motors.

The Application of Oil Engines to Light Marine Work. Capt. C. C. Longridge. Considers the advantages and defects of these motors for marine work, and describes methods of reversing. 2200 w. Naut Gaz—Sept. 11, 1902. No. 50482.

Repairs.

Building a New Bottom for a Wrecked Ship. Illustrated description of the extensive repairs to the U. S. transport, McPherson, which went ashore on the South coast of Cuba. 700 w. Marine Engng—Sept., 1902. No. 50306 C.

Shipping.

Queer Craft Seen on My Travels in the Philippines, China and South America. E. C. Rost. Brief illustrated descriptions of strange boats. 1200 w. Sci Am—Sept. 13, 1902. No. 50490.

Steam Engines.

See Mechanical Engineering, Steam Engineering.

Steamships.

Brief History of Ocean Steamships. Lawrence Irwell. An account of some of the earliest steamers of the world, and the process of development. 5900 w. Marine Rev—Sept. 11, 1902. No. 50527.

Fishing Steamer. Description and plan

We supply copies of these articles. See page 325.

of a unique fishing steamer for service in Southern waters, to be used in gathering the catch from the fishing fleet and bringing it to market. 450 w. Marine Engng—Sept., 1902. No. 50303 C.

New Steamship Kroonland of the International Navigation Company. An illustrated detailed description of this largest ship yet built in American waters, noting features of interest in design and in construction work. 3300 w. Marine Engng—Sept., 1902. No. 50299 C.

Shallow Draught Steamer. Illustrates and describes a new feature introduced by Yarrow & Co. into screw-propelled boats of this type by reason of which great economy is claimed. 600 w. Engr, Lond—Aug. 22, 1902. No. 50364 A.

The Twin Screw Express Steamship Kaiser Wilhelm II. (Doppelschrauben-Schnelldampfer Kaiser Wilhelm II.) A general account of the new steamer of the North German Lloyd, with especial reference to the launch. 2000 w. Stahl und Eisen—Sept. 1, 1902. No. 50751 D.

Steam Trials.

Steam Trials of H.M.S. "King Alfred." Editorial on the performance of this armored cruiser, which was highly satisfactory. 1500 w. Engng—Sept. 5, 1902. No. 50572 A.

Steering Gear.

Steam Steering Gear. Arthur Masters. Considers the advantage of steam over hand gears, types of steam steering gear and methods of transmission. Ill. 3200 w. Mach, N Y—Sept., 1902. No. 50387.

Submarines.

Submarine Boats. Editorial review of opinions held as to the value of the submarine boat. 3700 w. Engng—Sept. 5, 1902. No. 50570 A.

Towboat.

Steel Towboat Vesta for the Monongahela River. Illustrated description of a boat to be used mainly in towing coal from the mines to the mills and furnaces. 3000 w. Marine Engng—Sept., 1902. No. 50304 C.

Towing.

Old-Time Towing on the Detroit River. George Lansing. An illustrated article giving a review of past conditions on the St. Clair and Detroit Rivers. 2400 w. Naut Gaz—Aug. 28, 1902. No. 50249.

Yachts.

The Steam Yacht "Arrow"—The Fastest Boat in the World. Illustrated description of this fine yacht which recently covered a nautical mile in 1 min. 32 sec. 1600 w. Sci Am—Sept. 20, 1902. No. 50600.

MECHANICAL ENGINEERING

AUTOMOBILES.

Accumulators.

See Electrical Engineering, Electro-Chemistry.

Bearings.

Adjustable Bearings a Requisite of the Practical Automobile. Albert L. Clough. Gives the writer's views and also a brief editorial disagreeing with some points. 1500 w. Horseless Age—Sept. 17, 1902. No. 50580.

Design.

Design and Workmanship. Albert L. Clough. Considers the failures due to design and to faulty material and workmanship in the progress of the automobile industry. 1100 w. Horseless Age—Aug. 27, 1902. No. 50250.

Gasoline Vehicles.

The Loomis Carbureter and Muffler. Illustrated description of articles named which have been in use for some time on gasoline vehicles. 600 w. Sci Am—Sept. 13, 1902. No. 50487.

Harvester.

A Giant Automobile Harvester at Work. Brief illustrated description. 200 w. Rev of Revs—Sept., 1902. No. 50327 C.

Journals.

Some Notes on Journal Friction. J. S. V. Bickford. Gives results of experimental investigations. 3800 w. Horseless Age—Sept. 3, 1902. No. 50413.

Lurries.

A Novel Type of Steam Lurry. Illustrated description of the type adopted by the Pioneer Power Co., of London, Limited. The platform extends almost the entire length, as little of the upper space as possible being taken for the driver's seat, or machinery. 2500 w. Auto Jour—Aug. 30, 1902. No. 50455 A.

Dr. Brightmore's Steam Lurry. Illustrated detailed description of this machine and its operation, describing a trial trip. 4600 w. Auto Jour—Aug. 23, 1902. No. 50345 A.

Report on the War-Office Motor Lorry Trials. Report of a test made of self-propelled lorries to determine their capabilities for military purposes. 900 w. Engr, Lond—Sept. 5, 1902. No. 50567 A.

Motors.

Automobiles and Motors (Automobiles

We supply copies of these articles. See page 325.

et Moteurs). Eugène Brillié. Describing the double-acting internal combustion motor of the author's design, and its applications to mechanically propelled vehicles. 5000 w. Bull Soc d'Encour—Aug. 31, 1902. No. 50735 G.

Petrol Motor Troubles and Their Location. Directions for the care of petrol motors, and for finding out the cause of troubles. 1500 w. Motor Car Jour—Aug. 23, 1902. No. 50346 A.

Races.

The Brighton Beach Races. An illustrated report of these races held under the auspices of the Automobile Club of Long Island. 1400 w. Horseless Age—Aug. 27, 1902. 50251.

Resistance.

Traction, Grade and Air Resistance. Reynold Janney. Explains method of calculation, giving chart. 1200 w. Horseless Age—Sept. 17, 1902. No. 50581.

Steam Trucks.

Steam Motor Trucks. Illustrated description of the steam trucks made by the Morgan Motor Co., Worcester, Mass. 1500 w. Mach, N Y—Sept., 1902. No. 50388.

Trials.

Automobile Clubs 650 Miles Reliability Trial. A continued illustrated description of each day's journey, with editorial remarks. 8000 w. Auto Jour—Sept. 13, 1902. No. 50609 A.

Some Mechanical Details Noted in the 650 Miles Trials. Comments with illustrations. 3800 w. Autocar—Sept. 13, 1902. No. 50610 A.

The Meeting at Deauville. An illustrated account of speed tests, the most successful yet held. 4600 w. Autocar—Sept. 6, 1902. No. 50555 A.

The 650 Miles Reliability Trials of the A. C. G. B. I. An illustrated account of the trials with editorial. 7500 w. Auto Jour—Sept. 6, 1902. No. 50554 A.

HYDRAULICS.

Building Supply.

Water Supply System in the Maiden Lane Building, New York. Illustrated description of the installation for an 18-story office building. 1300 w. Eng Rec—Sept. 6, 1902. No. 50450.

Flow.

New Ways of Measuring Water. Information for the use of farmers who irrigate their land, given by Director Samuel Fortier of the Montana Experimental Station. 1400 w. Sci Am—Sept. 13, 1902. No. 50486.

The Flow of Water in Wood Pipes. Theron A. Noble. Gives a brief illustrated description of the gravity supply of Seattle, Wash, and discusses a series of experiments conducted by the writer. 8000 w. Pro Am Soc of Civ Engrs—Aug., 1902. No. 50427 E.

Hydro-Electric Stations.

See Electrical Engineering, Generating Stations.

Nozzles.

Discharge Nozzles for High Head. W. Stuart Smith. Discusses improperly shaped nozzles and their effects. Ill. 2800 w. Jour of Elec—Aug., 1902. No. 50253.

Plumbing.

The Range Boiler and Water Front. M. L. Kaiser. An illustrated article discussing the right and wrong ways of setting and connecting of the range boiler and water front. 4500 w. Met Work—Sept. 20, 1902. No. 50598.

Pumping Engines.

How to Obtain the Best Results in Small Pumping Stations. Harry F. Gibbs. How to get the best of the existing conditions is discussed, considering points of importance. 2400 w. Jour N E W Wks Assn—Sept., 1902. No. 50436 F.

Small Pumping Engines. Topical discussion by William F. Codd and D. N. Tower of plants equipped with oil-engines. Ill. 1000 w. Jour N E W Wks Assn—Sept., 1902. No. 50437 F.

Pumps.

Improved Steam Pumping Machinery (Einige Neuere Pumpmaschinen mit Dampfbetrieb). H. Becher. Data and results of tests of recent waterworks pumping engines built by Kuhn of Stuttgart. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 23, 1902. No. 50706 D.

Rotative Pumping. John Richards. A review of the development of this class of machinery, especially describing the Sulzer pumps, and the principles of the turbine type. Ill. and discussion. 8000 w. Jour Assn of Engng Socs—Aug., 1902. No. 50693 C.

Turbines.

Notes on the History of Turbine Development in America. A. C. Rice. An interesting review of water-wheel development, especially of the turbine design. 3300 w. Eng News—Sept. 18, 1902. No. 50588.

Water Power.

The Control of Non-Navigable Streams by the National Government. Informal discussion in view of the numerous disasters caused by the contracting of channels, or the damming of small streams, whether they should not be under the control of the national government. 4000 w. Pro Am Soc of Civ Engrs—Aug., 1902. No. 50432 E.

Water Power Projects at Joliet, Ill. An explanation of projects now before the courts for a decision as to their respective

rights, showing the general situation. Ill. 900 w. Eng News—Sept. 4, 1902. No. 50401.

MACHINE WORKS AND FOUNDRIES.

Bonus System.

See Industrial Economics.

Castings.

Casting a Round Tank. R. H. Palmer. Illustrates and describes one of the ways of molding and pouring a tank of this kind. 1100 w. Am Mach—Aug. 28, 1902. No. 50261.

The Calculation of the Weight of Castings with the Aid of the Planimeter. C. M. Schwerin. Describes a graphic method for estimating the weight of a casting when the cross-section is not a uniform geometrical figure. 700 w. Trans Am Inst of Min Engrs—Sept., 1902. No. 50678 C.

Cataloging.

Cataloging Small Machine Parts. L. P. Alford. Describes a system used in cataloging and arranging the data regarding the small parts of about 150 machines. 2000 w. Am Mach—Sept. 25, 1902. No. 50697.

Chain Making.

The Locke Steel Chain. Illustrated description of this automatic machine made chain, noting the operations, and commending the product. 1200 w. Engng—Aug. 22, 1902. No. 50370 A.

Corkscrews.

A Machine for Twisting Corkscrews. Joseph V. Woodworth. Illustrated description of the machine and its operation. 400 w. Am Mach—Sept. 25, 1902. No. 50696.

Cost-Keeping.

See Industrial Economics.

Cranes.

Counterbalances for Locomotive Cranes. Robert H. Kirk. Gives a graphical method of determining the quantity of counter weight for locomotive cranes. 1200 w. Am Mach—Sept. 18, 1902. No. 50583.

Notes on Crane Design. A. D. Williams. A discussion of points relating to crane wheels. Ill. 1000 w. Am Mach—Sept. 11, 1902. No. 50501.

See Electrical Engineering, Power Applications.

Dies.

Blanking Dies. Joseph V. Woodworth. Concerning the making and using of piercing and blanking dies. Ill. 2500 w. Mach, N Y—Sept., 1902. No. 50386.

The Making and Use of Simple Dies. Peter Chiampon. Illustrated descriptions of a number of dies found very useful in the average machine shop. 1200 w. Am Mach—Sept. 25, 1902. No. 50698.

Draughtsmen.

The Relations of the Draughtsman to the Workshop. W. H. Booth. A discussion of this fundamental question of efficient shop organization including the preparation and execution of designs for engineering work. 3000 w. Engineering Magazine—October, 1902. No. 50788 B.

Drilling.

See Electrical Engineering, Power Applications.

Drills.

Use of Ratchet and Other Hand-Machine Drills in the Cleveland Mines. William Charlton. Read before the N. of Eng. Inst. of Mech. & Min. Engrs. Brief account of the practice in these mines and the advantages. 1500 w. Ir & Coal Trds Rev—Sept. 19, 1902. No. 50820 A.

Foundry Operation.

Important Questions in Connection with Foundry Operation (Wichtige Frage im Giessereibetriebe). A comparison of German and American practice, showing the advantages of mechanical transport. Serial. Part I. 3000 w. Stahl und Eisen—Sept. 1, 1902. No. 50753 D.

Grinder.

Disc Grinder. Illustrated description of a 20-inch universal disc grinder of the "mechanical fitter" type manufactured in England. 800 w. Engr, Lond—Aug. 22, 1902. No. 50367 A.

Hardening.

Steel and Its Treatment. E. R. Markham. Discussing methods of heating of steel for hardening, in the present article. Ill. 2700 w. Mach, N Y—Sept., 1902. No. 50385.

Hoisting.

Determining the Size of Hoisting Plants. Edward B. Durham. Discusses methods of calculating. Ill. 5500 w. Trans Am Inst of Min Engrs—Sept., 1902. No. 50681 C.

Machine Design.

A Tendency in Machine Design. Editorial mainly discussing the tendency to smoothness of outline in steam-engine practice. 1800 w. Engng—Sept. 5, 1902. No. 50571 A.

Machine Driving.

See Electrical Engineering, Power Applications.

Machine Shops.

A Visit to the Works of the General Electric Company. Lyman B. Thompson. An illustrated detailed description of these extensive works. 5800 w. Am Mach—Sept. 4, 1902. No. 50440.

The American Steel Casting Company's New Plant at Alliance. Illustrated de-

tailed description. 2500 w. Ir Age—Sept. 25, 1902. No. 50669.

The Ferranti Works at Hollinwood. Illustrates and describes the works and some of the products of one of the oldest electrical engineering concerns in England. 2200 w. Elec Times—Aug. 28, 1902. Serial. 1st part. No. 50452 A.

The New Machine Works of Louis Soest & Co. (Neuanlage der Maschinenfabrik Louis Soest & Co.) W. Grueber. Describing an important new plant near Düsseldorf, devoted to the manufacture of steam and gas engines, as well as mining and general machinery. 2500 w. Stahl und Eisen—Sept. 1, 1902. No. 50752 D.

The Science of the Workshop. William Taylor. Read at Belfast meeting of the Brit. Assn. for the Adv. of Science. Discusses materials, processes and tools, tracing the foundation of this science. 4500 w. Engng—Sept. 19, 1902. No. 50818 A.

The Works of Messrs. Belliss and Morcom, Limited. An illustrated description of these works which have attained a high reputation as makers of high-speed engines, and also of their equipment. 5000 w. Engng—Sept. 19, 1902. No. 50814 A.

Machine Tools.

Improvements in Machine Tools (Neuerungen im Werzeugmaschinenbau). Hermann Fischer. Describing especially minor details of construction in recent German lathes and drilling machines. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 23, 1902. No. 50705 D.

Machine Work.

Inaccurate Machine Work on Cylinders and Pistons. Albert L. Clough. A criticism on work observed on three horizontal gasoline vehicle engines. 1200 w. Horseless Age—Sept. 10, 1902. No. 50496.

Mannesmann Tubes.

Notes on the Manufacture of Weldless Steel Tubes by the Mannesmann Process. J. H. H. Barrée. Read before the South Wales Inst. of Engrs. An illustrated article fully describing the process. 3000 w. Ir & Coal Trds Rev—Aug. 22, 1902. No. 50358 A.

Ordnance.

Ordnance Engineering as a Great Mechanical Industry. J. V. Meigs. A fully illustrated review of the present state of the art of ordnance engineering as one of the most highly developed mechanical industries. 4000 w. Engineering Magazine—October, 1902. No. 50784 B.

Roller Bearings.

The Essential Conditions of Sliding and Roller Bearings (Die Wesentlichen Eigenschaften der Gleit-und Rollenlager). Prof. R. Stribek. A comparison of the resistance of journal friction with the action of roller bearings; with diagrams showing the effect of various lubricants. Serial. Part I. 2500 w. Zeitschr d Ver Deutscher Ing—Sept. 6, 1902. No. 50712 D.

See Marine Engineering.

Shells.

The Drawing of Deep Shells from Sheet Metal. Joseph V. Woodworth. An illustrated article showing what has been accomplished. 600 w. Am Mach—Sept. 18, 1902. No. 50586.

Turning.

Time Required to Turn a Piece. Robert Grimshaw. Information concerning the time required to perform machine tool operations. 1000 w. Ir Trd Rev—Sept. 4, 1902. No. 50383.

Works Management.

See Industrial Economics.

MATERIALS OF CONSTRUCTION.

Beam Section.

Broad Flanged I-Beams (Breitflanschige I-Träger). R. Cramer. A discussion of the advantages and manufacture of the beam of the section designed by Henry Grey, of Pittsburg, Pa., as made by the Differdingen works in Luxemburg. 1800 w. Zeitschr d Ver Deutscher Ing—Aug. 16, 1902. No. 50702 D.

Cast Iron.

Effect of Variations in the Constituents of Cast Iron. W. G. Scott. Read before the International Assn. of Test. Materials. Describing the influence of metalloids on cast iron as observed under practical conditions, without regard to theory. 7000 w. Foundry—Sept., 1902. No. 50323.

Iron Protection.

See Electrical Engineering, Electro-Chemistry.

Lubricants.

Cylinder Lubrication. J. S. V. Bickford. Reports of tests of oils for heat resisting properties, and of cylinder oils under steam conditions, etc. Ill. 3500 w. Horseless Age—Sept. 24, 1902. No. 50670.

Masts.

The Strength of Derrick Masts (Die Festigkeit von Lademasten). H. Sellentin. An analytical examination of the stresses upon the masts of hoisting derricks under various conditions of loading. Serial. Part I. 2000 w. Schiffbau—Aug. 23, 1902. No. 50775 D.

Specifications.

Discussion of Proposed Standard Specifications for Steel Forgings and Castings. Gus C. Henning. A critical discussion of the standard international specifications proposed. 4000 w. Trans Am Inst of Min Engrs—Sept., 1902. No. 50682 C.

Specifications for Foundry Supplies. Gives specifications for foundry materials

received from Mr. W. G. Scott of the Case Threshing Machine Co. 6700 w. Eng News—Sept. 11, 1902. No. 50503.

Steel.

Deterioration of Steel from Vibration. A discussion of this subject concluding that the deterioration under vibration is less potent than the use of faulty material. 2400 w. Engr, Lond—Sept. 19, 1902. No. 50812 A.

The Overheating of Mild Steel. E. Heyn. Read before the Iron and Steel Inst. An account of the writer's experiences regarding the brittleness produced in mild steel by overheating. The experiments refer only to mild steel such as is employed in boiler plates, structural material, wire, etc. 5000 w. Engng—Sept. 12, 1902. Serial. 1st part. No. 50638 A.

Test Bars.

Test Bars—Some Foundation for Comparisons. Asa W. Whitney. Remarks on certain relations to be considered as applying to various cast sections and test bars. 1500 w. Foundry—Sept., 1902. No. 50324.

Tool Steel.

The Recent Development of Tool Steel. Edmund L. French. Extract from a paper read before the Am. Assn. for the Adv. of Science. Discusses the advancement made in the production of "special steels." 1400 w. Eng News—Sept. 25, 1902. No. 50674.

MEASUREMENT.

Calorimeter.

The Respiration Calorimeter. Description of machines for measuring and recording the changes in air supplied to living beings, including temperature, chemical composition, etc. 2000 w. Am Mach—Sept. 11, 1902. No. 50500.

Journal Friction.

Testing Apparatus for Lubricants and Bearing Metals (Ueber einen Apparat zur Untersuchung von Lagerölen und Lagermetallen). G. Dettmar. An electrically driven apparatus, enabling the friction of jourals to be determined for high rotative speeds, for various lubricants and bearing metals. 4000 w. Elektrotech Zeitschr—Aug. 21, 1902. No. 50756 B.

Metric System.

The Metric System of Weights and Measures. A copy of the circular sent announcing the purposes of a special meeting for the discussion of the metric system, with proceedings of the meeting. 1700 w. Jour W Soc of Engrs—Aug., 1902. No. 50285 D.

Standards.

The National Bureau of Standards. Prof. S. W. Stratton. Historical review of what has been done by the U. S. Congress, and discussion favoring the compulsory use of the metric system. 8000 w. Jour W Soc of Engrs—Aug., 1902. No. 50284 D.

POWER AND TRANSMISSION.

Compressed Air.

Abuse in the Use of Compressed Air. W. L. Saunders. Calling attention to the unhealthfulness of discharged compressed air when impregnated with bad oils, and suggesting remedies. 1400 w. Compressed Air—Sept., 1902. No. 50484.

Comparison of Costs of Compressing Air with Steam and Electricity at Rossland, B. C. William Thompson. Read before the Canadian Mining Inst. Describes the steam plant erected for the Le Roi Mining Co., and the electric plant erected by the Rossland Great Western Mines, Limited, comparing their economy and relative efficiency. 2200 w. Can Min Rev—Aug. 30, 1902. No. 50296 B.

Compressed Air Calculations. W. C. Popplewell. The first of a series of articles discussing how the necessary calculations are to be made. 1700 w. Mech Engr—Aug. 23, 1902. Serial. 1st part. No. 50336 A.

Quadruplex Two-Stage Air Compressors. Illustrated detailed description of the Reavell air compressor. 2000 w. Engr, Lond—Aug. 22, 1902. No. 50363 A.

Elevator Safeties.

Elevator Safety Governors. William Baxter, Jr. Illustrates and describes a safety governor mounted directly upon the elevator car, and driven by a stationary rope which is secured to the top and bottom of the elevator well. Also shows a balanced governor. 1400 w. Am Mach—Sept. 18, 1902. No. 50584.

Improved Safety Catch for Elevators (Neue Fangvorrichtung an Fahrkörben). W. Schrader. Describing a new wedge device for supporting the cage of a lift in case of breakage of the hoisting cables. 1500 w. Zeitschr d Ver Deutscher Ing—Aug. 16, 1902. No. 50703 D.

Linkage.

The Construction of the Pole Paths and Normals of a Linked Quadrilateral (Konstruktion der Normalen und der Krümmungskreise der Polbahnen der Vierzylinderkette). W. Hartmann. A kinematic analysis of the movements of the joints of a quadrilateral linkage, by the method of instantaneous centres. 2000 w. Zeitschr d Ver Deutscher Ing—Sept. 6, 1902. No. 50713 D.

Power Plant.

The Power Plant of the Stecher Lithographic Company, Rochester, N. Y. Illustrated description of the lighting, heating and ventilating installation in a 2-story, 146 x225-ft. building. 2000 w. Eng Rec—Sept. 27, 1902. No. 50825.

We supply copies of these articles. See page 325.

SPECIAL MOTORS.

Alcohol.

Motors, Boats and Automobiles Operated by Alcohol (Les Moteurs, les Automobiles et les Bateaux à Alcool). M. Ringelmann. A description of the testing plant by use of which the efficiency of the internal-combustion motors using alcohol as fuel can be found. 3500 w. Bull Soc d'Encour—Aug. 31, 1902. No. 50733 G.

Diesel Motor.

Test of a Diesel Oil Engine. H. Ade Clark. Describes an interesting test made by the writer, giving tabulated results. Ill. 2000 w. Engr, Lond—Aug. 22, 1902. No. 50366 A.

Gas Engines.

A New 2,300-H. P. Gas Engine Installation for High-Pressure Fire Service in Philadelphia. Illustrated description of engines for the new fire station. 1200 w. Eng News—Aug. 28, 1902. No. 50268.

Cylinder Charge Firing. Hugh Dolnar. Considers the electric spark charge firing the best, and explains the action of the three forms,—"wipe," "manner" and "jump" sparks. 3000 w. Autocar—Aug. 30, 1902. No. 50454 A.

Recent Developments in the Gas Engine. Prof. T. Hudson Beare. Extracts from a lecture delivered to the Graduates' Sec. of the Inst. of Mech. Engrs., England. On the use of blast-furnace waste gases, their heating value, etc. 3500 w. Ir Trd Rev—Sept. 18, 1902. No. 50582.

Recent Progress in Large Gas Engines. Herbert A. Humphrey. Read at Belfast meeting of the British Assn. Remarks on the progress with illustrated descriptions of various types. 3000 w. Engng—Sept. 19, 1902. Serial. 1st part. No. 50816 A.

The Internal Combustion Engine. Ed. C. de Segundo. On the future outlook for this class of engines. 1200 w. Elec Rev, Lond—Aug. 29, 1902. No. 50461 A.

The Selection of Gas Engines. J. D. Lyon. Briefly considers points that should be taken into account in the selection. 1500 w. Eng Rec—Sept. 6, 1902. No. 50451.

Gasoline.

Various Applications of the Gasoline Motor. Gives illustrations with brief descriptions of a number of applications. 1200 w. Sci Am—Sept. 13, 1902. No. 50488.

Gas Power.

Blast Furnace Gas Power. Horace Allen. Discusses this gas as an important source of cheap power. 2500 w. Elec Rev, Lond—Sept. 12, 1902. No. 50623 A.

Generator Gas Plant for Electric Driving (Generatorgas-Anlagen für den Betrieb von Elektricitätswerken). Fr. Ross. Describing especially the installations at Pressburg, Erlangen, and elsewhere in Austria, using water gas in gas engines for driving dynamos. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 15, 1902. No. 50728 B.

Utilization of Blast Furnace Gas in Gas Engines at the Ilseder Works (Verwerthung der Hochofengase in Gasmaschinen auf der Ilseder Hütte). F. W. Lürmann. Describing a plant in which two engines of 1000 h. p. each driving dynamos and one blowing engine of 600 h. p. are operated by furnace gas, at Ilsenberg, in the Harz. 1200 w. Stahl & Eisen—Aug. 15, 1902. No. 50750 D.

Ignition.

Gas Engine Ignition by Contact or Catalytic Action. Dr. Paul Gans de Fabrice, in *La Locomotion*. Reviews attempts made to utilize the catalytic properties of platinum for ignition in explosive motors, and describes the electro-catalytic sparking plug invented by the writer. 1500 w. Sci Am Sup—Sept. 13, 1902. No. 50491.

Guillon Igniter for Explosion Motors. Illustrated description of an ignition appliance invented by M. Henri Guillon. 1200 w. Prac Engr—Sept. 5, 1902. No. 50558 A.

Internal Combustion Motors.

See Mechanical Engineering, Automobiles.

Oil Motors.

See Marine Engineering.

STEAM ENGINEERING.

Chimney Stability.

The Statical Computations for the Stability of a Chimney (Beiträge zur Statischen Untersuchung von Schornsteinen). A mathematical investigation of the stabilty of masonry chimneys by M. Preuss and G. Lang, discussing the accuracy of the formula of Müller-Breslau, and the tables based upon it. 1500 w. Zeitschr d Ver Deutscher Ing—Aug. 30, 1902. No. 50710 D.

Engine Erection.

The Erection of High-Speed Center-Crank Engines. H. V. Hunt and C. G. Robbins. Aims to give clear and concise directions for the erection of a high-speed center crank engine. Ill. 2800 w. Power—Sept., 1902. No. 50258 C.

Engine Tests.

English and American Engines for Glasgow Tramways. A copy of the figures obtained by Prof. Barr when making his official tests on the Pinkston engines, with brief remarks. 500 w. Elec Rev, Lond—Sept. 12, 1902. No. 50617 A.

Flue Gases.

Reclaiming Waste Heat from Flue Gases. C. G. Robbins. Illustrates and

describes a typical economizer, also an arrangement for preheating the air before admitting it to the fire, discussing both systems. 2200 w. Engr, U S A—Sept. 15, 1902. No. 50665.

Fly-Wheels.

Speed for Fly-Wheels. W. H. Boehm. How to determine the speed at which disrupture will occur. 800 w. Ir & Coal Trds Rev—Aug. 29, 1902. No. 50469 A.

Oil Fuel.

Petroleum as Fuel. William Kent. A study of the practical relative values of petroleum and coal. 4500 w. Power—Sept., 1902. No. 50259 C.

See Marine Engineering.

Power Plant.

The Steam Plant of the Carpenter Steel Company, Reading, Pa. Illustrates and describes a 1200 h. p. plant. 1500 w. Eng Rec—Sept. 6, 1902. No. 50445.

Pumping Engines.

See Mechanical Engineering, Hydraulics.

Rolling Mills.

Steam Generation for Large Rolling Mills. J. R. Bibbins. An illustrated description of a boiler plant embodying novel constructive features recently installed for the Lukens Iron & Steel Co., Coatesville, Pa. 2200 w. Ir Age—Sept. 25, 1902. No. 50666.

Smoke.

The Treatment of Smoke. W. N. Shaw. Lecture before the Sanitary Inst. (England). Discussing the problem of smoke abatement and suggesting the erection of municipal chimneys, or orifices for the delivery of the smoke of a number of chimneys, and thus making it possible to deprive the smoke of its soot. 3000 w. Archt, Lond—Sept. 12, 1902. Serial. 1st part. No. 50606 A.

Speed Regulation.

The Regulation of Steam Engines (Der Reguliervorgang bei Dampfmaschinen). Dr. B. Rülf. A graphical and mathematical analysis of the conditions affecting the speed variations of reciprocating engines, and the action of regulating devices. Two articles. 5500 w. Zeitschr d Ver Deutscher Ing—Aug. 30, Sept. 13, 1902. No. 50709 each D.

See Electrical Engineering, Generating Stations.

Steam Engines.

A Rolling Mill Engine of 6000 H. P. Illustrated detailed description of a very large and powerful steam engine for a rolling mill in Youngstown, O. 2000 w. Eng News—Aug. 28, 1902. No. 50266.

A Wonderful Old-Time Engine in Scotland; Still Working After Sixty Years' Constant Service. Benjamin Taylor. An illustrated description and historical account of a standing engine for hauling trains up an incline at Glasgow, on the North British Railway. 1100 w. Power—Sept., 1902. No. 50256 C.

English and American Engines for the Glasgow Tramways. An editorial severely criticizing the Allis engines, and the reports concerning them which have appeared in the British and American papers. 2400 w. Elec Rev, Lond—Aug. 29, 1902. No. 50459 A.

Some Considerations Affecting the Economy of Marine Screw Engines. E. Hall-Brown. Discussion of this paper which was read before the Inst. of Engrs. & Shipbuilders in Scotland. 3 plates. 7500 w. Trans of Inst of Engrs & Shipbldrs in Scotland—Aug., 1902. No. 50338 D.

The Engines of the Glasgow Tramways. Editorial Comment on the engines furnished by the three firms and their trials. 1600 w. Engng—Aug. 22, 1902. No. 50372 A.

The Glasgow Tramway Engines. Editorial reviewing the leading points in the story of the two types of main engines and their tests. 3300 w. Engng—Sept. 12, 1902. No. 50636 A.

Steam Consumption and Maximum Horse-Power. Discusses the requirements in the specifications of condensing engines. 1100 w. Power—Sept., 1902. No. 50257 C.

Steam Turbines.

Tests of Steam Turbine Installed at Hartford, Conn. Prof. William Lispenard Robb. A summary of the tests made by the writer to determine the efficiency that would be obtained under the actual operating conditions at Hartford. 800 w. Elec Wld & Engr—Sept. 6, 1902. No. 50442.

Superheaters.

Some Notes on the Construction and Operation of Flue-Fired Superheaters. H. Cruse. Considers the construction, materials and management of superheaters. 2400 w. Elec Times—Aug. 21, 1902. No. 50335 A.

Surface Condensers.

A Rational Determination of the Dimensions of Surface Condensers (Determinazione Razionale delle Dimensione Principali dei Condensatori a Superficie). Natale Matteucci. A review of the existing formulas and the development of new rules based on the actual heat exchanges. Rivista Marittima—Aug.-Sept., 1902. No. 50774 H.

Valve Gears.

Speed of Engines Fitted with Trip Valve Gear. Abstract of the individual replies to inquiries as to the speeds used by a number of engine builders for Corliss engines fitted with trip or releasing valve gear. 2500 w. Engr, Lond—Aug. 29, 1902. No. 50475 A.

We supply copies of these articles. See page 325.

MISCELLANY.

Aeronautics.

The Development of the Air-Ship. John M. Bacon. An interesting review of attempts to navigate the air dating back hundreds of years, and considering the outlook hopeful. 4500 w. Nineteenth Cent—Sept., 1902. No. 50604 D.

Alcohol.

Lighting and Heating by Alcohol (L'Eclairage et le Chauffage par l'Alcool). M. Lindet. Describing especially the various forms of lamps in which an incandescent mantle is heated by alcohol for the production of light. 10,000 w. Bull Soc d'Encour—Aug. 31, 1902. No. 50732 G.

Composing Machine.

The Meray-Rozar Electrotypographic Machine. An illustrated description of this composing machine and its operation. 1000 w. Sci Am Sup—Aug. 30, 1902. No. 50245.

Düsseldorf Exposition.

Machinery for the Textile Industries (Die Arbeitsmaschinen für die Textilindustrie). G. Rohn. The first of a series of illustrated papers describing the textile machinery exhibited at Düsseldorf, 1902. Serial. Part I. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 30, 1902. No. 50708 D.

Hose.

Manufacture of Rubber Hose. Charles Dunn. Describes one method of manufacturing air and steam hose. 1100 w. Loc Engng—Sept., 1902. No. 50418 C.

Hot-Water Heating.

Hot Water Heating for Domestic Service. H. C. Lincoln. An illustrated outline of the different systems in common use, with a few rules for the design of such systems. 2500 w. Steam Engng—Sept. 10, 1902. No. 50561.

The Reck System of Heating by Hot Water (Die Warmwasserheizung von Reck). H. Fischer. Describing a combination of a hot water heater with a steam boiler for house heating. 1200 w. Zeitschr d Ver Deutscher Ing—Sept. 6, 1902. No. 50714 D.

Lighting.

The Development of Lighting and Heating (Neuerungen auf dem Gebiete des Beleuchtungs- und Beheizungswesens). Franz Walter. The first of a series of articles of a historical character; this instalment describes early gas works in Vienna. Serial. Part I. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 5, 1902. No. 50731 B.

Mechanical Engineers.

The Mechanical Engineer a Factor in Modern Mining, Milling and Smelting. C. H. Repath. Read at the Butte meeting of the Min. Cong. A resume of smelting operations in Montana, and the part taken by the mechanical engineer. 5800 w. Min & Sci Pr—Sept. 13, 1902. No. 50596.

Mechanical Plant.

The Mechanical Plant in a Newark, N. J., Department Store. Illustrates and describes the interesting plant installed in the store of Hahne Bros. 1700 w. Eng Rec—Aug. 30, 1902. No. 50319.

Sand Blast.

Sand Blast Machines (Les Machines à Jet de Sable). A. de Riva-Berni. Illustrating a number of devices for utilizing the abrading action of the sand blast in the arts. 2500 w. 1 plate. Génie Civil—Sept. 6, 1902. No. 50727 D.

Schoolhouse.

Ventilating and Heating No. 23 School, Rochester, N. Y. Illustrated description of a 22-room school with a fan system of ventilation and direct steam radiation. 2200 w. Eng Rec—Sept. 20, 1902. No. 50647.

Wood-Working Tools.

A Study of Wood-Working Machinery (Etude sur les Machines-Outils Utilisées dans le Travail de Bois). Paul Razous. A comprehensive study of wood working machinery, with numerous illustrations. The first article treats of sawing machines. Serial. Part I. 5000 w. Revue de Mécanique—Aug. 31, 1902. No. 50736 E+F.

MINING AND METALLURGY

COAL AND COKE.

Breaker.

The Auchincloss Breaker. George L. Carlisle, Jr. An illustrated description of the novel methods employed in construction, and in arrangement and driving of the machinery of this breaker at Nanticoke, Pa. 2800 w. Mines & Min—Sept., 1902. No. 50514 C.

British Columbia.

A Description of the Mining Operations, Pumping and Hauling Plant, etc., at the Comox Colliery. Jno. Matthews. 1800 w. B C Min Rec—Sept., 1902. No. 50498 B.

Cape Colony.

The Indwe Coal Mines, Cape Colony. A description of these mines which pro-

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duce nearly 70 per cent. of the total coal mined in Cape Colony. Ill. 3300 w. Col Guard—Aug. 29, 1902. Serial. 1st part. No. 50467 A.

Coal Cutting.

See Electrical Engineering, Power Applications.

Colliery Developments.

Extensive Colliery Developments at Bathgate. Describes and illustrates the extensive work of the last ten years, the character of the coal, the equipment of the mines, etc. 2500 w. Col Guard—Aug. 22, 1902. No. 50359 A.

Disaster.

The Mount Kembla Disaster. An account of a terrible explosion in a colliery in New South Wales in which eighty-seven lives were lost. Also editorial. 2800 w. Aust Min Stand—Aug. 7, 1902. No. 50608 B.

Flat Coal Beds.

The Economic Theory of Shafts and Slopes for Flat Coal Beds. E. Brackett. A discussion of the economical means of raising the loaded mine cars for the purpose of screening the coal. 2400 w. Eng & Min Jour—Sept. 20, 1902. Serial. 1st part. No. 50650.

Lignite.

Power from Lignite in Germany. An account of large works in Germany where lignite is the only fuel used for steam-raising purposes. 700 w. Engr, Lond—Sept. 5, 1902. No. 50566 A.

Machines.

Pick and Chain Machines. L. J. Daft. A comparison of the two types from the standpoint of an advocate of pick machines. 3300 w. Mines & Min—Sept., 1902. No. 50510 C.

Pillars.

The Spacing of Pillars in the Brown-Coal Measures of Northwestern Bohemia (Schutzpfeilerbreite bei der Auskohlung des Braunkohlenflötzes in dem Nordwestböhmischen Becken). K. Balling. Giving the method of computing the pressures and the dimensions and spacing of pillars to sustain the roof with a minimum loss of coal. Serial. Part I. 1800 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 6, 1902. No. 50739 B.

Shop Records.

See Industrial Economics.

South Africa.

The Coal and Coalfields of South Africa. Information obtained from official sources. 5000 w. Col Guard—Sept. 19, 1902. No. 50810 A.

Turkey.

The Mineral Resources of Turkey—Coal. J. E. Spurr. Information concerning the deposits and their character. 1800 w. Engng & Min Jour—Sept. 6, 1902. No. 50424.

Washing Plant.

Coal-Washing Plant at Bathgate. Illustrated particulars of the plant at the Mosside Colliery. 2000 w. Col Guard—Sept. 5, 1902. No. 50564 A.

The Eastern Coal and Coke Company's Washer at Cokedale, Kan. W. R. Crane. Illustrated detailed description. 1600 w. Eng & Min Jour—Sept. 20, 1902. No. 50649.

Westphalia.

The Development of the Rhenish-Westphalian Coal District during the Past Century (Entwicklung der Rhenisch-Westfälischen Kohlenerzeugung während des Verflossenden Jahrhunderts). B. Schulz-Briesen. With a graphical diagram showing the great development from 1821 to 1900. 600 w. 1 plate. Glückauf—Aug. 23, 1902. No. 50741 B.

COPPER.

Leaching.

The Neill Leaching Process for Copper Ores. J. H. Burfeind. Describes this process, giving information concerning the cost, a statement of advantages claimed, etc. 3000 w. Min Rept—Sept. 11, 1902. No. 50528.

Smelting.

Metallurgical Practice at the Greenwood Smelter. Paul Johnson. From the report of the Minister of Mines, giving an account of work at the B. C. Copper Co.'s smelter. 1800 w. B C Min Rec—Sept., 1902. No. 50499 B.

GOLD AND SILVER.

Cyaniding.

The Direct Cyaniding of Wet-Crushed Ores in New Zealand. Hamilton Wingate. Gives particulars of experimental trials carried out on a working scale at the Waite-Kauri Extended mine, giving results and conclusions. 3800 w. Trans Am Inst of Min Engrs—Oct., 1902. No. 50684 C.

Deep-Level Mining.

Deep-Level Mining at the Thames. Abstracts from a memorandum of the government geologist of New Zealand. Describes the geology of the region, and considers points that need to be determined in connection with deep-sinking at this place, showing the possibility of workable gold at deep levels, and discussing how to reach it. 4500 w. N Z Mines Rec—July 16, 1902. No. 50342 B.

The Borehole at the Thames. F. B. Allen. Describes the material brought up from the borehole to test the deep ground of this district of New Zealand. 1100 w. N Z Mines Rec—July 16, 1902. No. 50343 B.

We supply copies of these articles. See page 325.

Georgia.

Gold Mining in McDuffie County, Georgia. W. H. Fluker. An account of the discovery of gold in this region and of the development. 2800 w. Trans Am Inst of Min Engrs—Sept., 1902. No. 50-680 C.

Gold Production.

The Gold Production of North America: Its Geological Derivation and Probable Future. Waldemar Lindgren. Portions of a paper read at the Butte, (Mont.) meeting of the Mining Congress. Interesting information concerning the geology of the gold deposits. 2500 w. Eng News—Sept. 18, 1902. No. 50587.

Idaho.

Facts About Thunder Mountain. Robert Bell. Illustrated description of this district. The most interesting features are the character of the gold deposits of the Dewy Mine, and the great development of acedic lavas. 3500 w. Eng & Min Jour—Aug. 30, 1902. No. 50307.

Kalgoorlie.

See Electrical Engineering, Power Applications.

Ontario.

Silver Mining in Ontario. An account of an important consolidation of some of the mines of Lake Superior, with notes on their past history. Ill. 3200 w. Can Min Rev—Aug. 30, 1902. No. 50295 B.

Quartz Mining.

A New and Promising Free-Milling Quartz Territory. J. F. Musselman. An illustrated article giving information and setting forth the advantages of the Fish River Camp, B. C., which is principally a producer of free-milling gold ore. 3000 w. B C Min Rec—Sept., 1902. No. 50-497 B.

Slimes.

Electrical Treatment of Slimes. F. T. Mumford. Read before the Aust. Inst. of Min. Engrs. The advantages to be gained by the electrical precipitation on mercury, describing the process. 2500 w. Aust Min Stand—July 24, 1902. No. 50334 B.

The Desulphurization of Slimes. E. J. Horwood. Read before the Aust. Inst. of Min. Engrs. On the advantages of heap roasting, and the method. 2800 w. Aust Min Stand—July 24, 1902. No. 50-332 B.

Smelting.

Inauguration of the Smelting Industry on Vancouver Island, British Columbia. William M. Brewer. An illustrated description of the plant recently put in operation, giving reasons for believing the plant to be advantageously located. 2400 w. Eng & Min Jour—Sept. 6, 1902. No. 50425.

IRON AND STEEL.

Armor.

Armor Plate at the Düsseldorf Exposition, 1902 (Der Panzer auf der Düsseldorfer Austellung 1902). J. Castner. A review of the exhibits at Düsseldorf, with data concerning recent trials of armor plate, by Krupp. 3000 w. Stahl und Eisen—Sept. 1, 1902. No. 50754 D.

Armor-Plate Exhibits at the Düsseldorf Exposition (Les Blindages a l'Exposition de Düsseldorf). L. Baclé. Discussing the exhibits, and giving a tabular view of the results of recent armor-plate tests. 2500 w. Génie Civil—Aug. 23, 1902. No. 50722 D.

Recent Trials of Armor Plates of Cemented Steel (Essais Récemment Pratiqués sur les Plaques en Acier Cémenté). L. Baclé. An account of recent tests in England and America upon surface hardened plates, including those with the Gathmann gun. 2500 w. Génie Civil—Aug. 30, 1902. No. 50724 D.

Blast Furnaces.

The Belgian-Ougree Blast Furnaces and Steel Works and Modern Electrically-Operated Plant. Frank C. Perkins. An illustrated article describing the electric power plant. The waste gases from the blast furnaces are utilized at a central power plant and the energy transmitted electrically for about three-quarters of a mile. 2500 w. Sci Am Sup—Sept. 27, 1902. No. 50809.

The Designing and Equipment of Blast Furnaces. Jno. L. Stevenson. The first of a series of papers aiming to set forth the practice and necessary methods, to arrive at the right size, shape, and proportions of any furnace adapted and suitable for the work it is intended to perform. Ill. 1800 w. Engr, Lond—Sept. 12, 1902. Serial. 1st part. No. 50629 A.

Blowing Engines.

Blast Furnace Blowing Engines at Donawitz Works, Austria (Hochofengebläse des Hüttenwerkes Danowitz). Description and illustrations of double vertical blowing engine delivering 1000 cubic metres of air per minute at a pressure of 0.7 atmosphere. 1000 w. Zeitschr d Ver Deutscher Ing—Aug. 23, 1902. No. 50-704 D.

Düsseldorf Exhibition.

Iron and Steel at the Düsseldorf Exhibition, 1902. Prof. Hermann Wedding. Read at meeting of the Iron & Steel Inst. A review of the extensive display of the metallurgy of iron and machine construction. 3200 w. Engng—Sept. 5, 1902. No. 50574 A.

Electric Smelting.

See Electrical Engineering, Electro-Chemistry.

Germany.

Twenty Years of the German Iron and Steel Industries. J. Stephen Jeans. A review of the progress of the various branches of the iron trade of the empire since 1880. Charts. 4500 w. Ir & Coal Trds Rev—Aug. 29, 1902. No. 50468 A.

Heat Treatment.

The Influence of Heating and Annealing upon the Resistance of Iron and Steel (Der Einfluss des Glühens und Abschreckens auf die Zugfestigkeit von Eisen und Stahl). A collection of the researches of Brinell, edited by Axel Wahlberg, discussing experiments made at the Fagersta Works, Sweden. 2500 w. Stahl und Eisen—Aug. 15, 1902. No. 50749 D.

Iron Works.

The Works of the Skinningrove Iron Company. Illustrated detailed description of this plant which has recently been thoroughly remodeled, and is considered one of the finest of its kind in Great Britain. 3500 w. Ir & Coal Trds Rev—Sept. 12, 1902. No. 50628 A.

Open Hearth.

A German Plate Mill and Open-Hearth Plant. From *Stahl und Eisen*. An illustrated account of the plate mill and open-hearth plant of the Rendsburg Steel and Rolling Mill. 1500 w. Ir Trd Rev—Sept. 11, 1902. No. 50485.

Pig Iron.

The Progress and Manufacture of Pig Iron in Germany since 1888. W. Brugmann. Read at meeting of the Iron & Steel Inst. The present article discusses the economic aspect of the industry, the development, the localities, etc. 5300 w. Engng—Sept. 5, 1902. Serial. 1st part. No. 50575 A.

Progress.

Progress in Steel Works Practice in Germany since 1880. R. M. Daelen. Read at meeting of the Iron & Steel Inst. An account of the recent progress and the improvements which have been effected. 3800 w. Engng—Sept. 5, 1902. No. 50576 A.

Steel Works.

The Rheinische Steel Works. Describes these works as typical of the very best modern German practice. 3000 w. Engr, Lond—Sept. 19, 1902. No. 50813 A.

The Steel-Plant at Monterey, Mexico. William White, Jr. Describes the deposits and gives plan and description of the plant. 2500 w. Trans Am Inst of Min Engrs—Nov, 1901. No. 50679 C.

MINING.

Accident.

Another Accident Caused by Oiling Machinery While in Motion. Describes a frightful accident at Beaumont, Otago, on a dredge which the engineer was oiling. 1200 w. N Z Mines Rec—July 16, 1902. No. 50344 B.

Blasting.

Remarkable Blasting Operations in Slate Quarries. Describes interesting blasting operations in Wales. Ill. 900 w. Sci Am—Sept. 6, 1902. No. 50404.

British Columbia.

Mining Industry and Mineral Resources of British Columbia. W. M. Brewer. Mr. Brewer's second paper gives a general survey of the mainland districts, including deposits of gold, copper and silver-lead. 4500 w. Engineering Magazine—October, 1902. No. 50785 B.

Notes on the Geology and a Few Ore Deposits of South Eastern British Columbia. C. V. Corless. Notes which seem to indicate that the ore bodies treated of form part of a related group. 9000 w. Can Min Rev—Aug. 30, 1902. No. 50298 B.

Colorado.

South Park, Colorado. Prof. Arthur Lakes. An illustrated description of its geology and economic resources in gold, silver, lead, coal and oil. 1800 w. Mines & Min—Sept.. 1902. No. 50513 C.

Concentration.

The Concentration of Ores by Oil. Illustrated description of an Elmore plant for this work. 900 w. Engr, Lond—Aug. 27, 1902. No. 50476 A.

Düsseldorf Exposition.

Mining Plant and Machinery (Die Bergbaulichen Anlagen). The first of a series of articles describing the mining exhibits at Düsseldorf, 1002. Two articles. 5000 w. Glasers Annalen—Aug. 15, Sept. 1, 1902. No. 50716 each D.

Explosives.

Mining Explosives. A. W. Warwick. Considers the effect of perfect and imperfect detonation, proper strength of caps for different conditions, etc. 2500 w. Mines & Min—Sept., 1902. No. 50512 C.

Firedamp.

The Investigation of Firedamp (Beiträge zur Untersuchung der Grubenwetter). F. Schrieber. A description of the Broockmann-Schondorff apparatus for the analysis of mine gases. 1200 w. Glückauf—Aug. 30, 1902. No. 50743 B.

First Aid.

First Aid to the Injured in Mining. Dr. George W. King. Abstract of a paper read before the International Min. Cong. A discussion of the causes of accidents and the methods of rescuing and aiding the injured. 3300 w. Engr & Min Jour—Sept. 13, 1902. No. 50543.

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Geology.

Application of Geology to Mining. J. E. Spurr. Read at the Butte meeting of the Min. Cong. On the assistance of each to the other and the advantage of working together. 2500 w. Min & Sci Pr—Sept. 13, 1902. No. 50597.

Igneous Rocks.

Crystalline Structure of Igneous Rocks. Thomas Andrews. Briefly considers the primary formation of igneous rocks, reproducing typical samples showing the crystalline structure, and describing the main groups. Ill. 900 w. Engng—Sept. 5, 1902. No. 50569 A.

Japan.

Mining in Japan. Fritz J. Frank. An illustrated description of the mines and plants of the Hokkaido Tanko Tetsudo Kaisha. 2200 w. Mines & Min—Sept., 1902. No. 50509 C.

Mine Drainage.

The Drainage Plant of the Horcajo Mines (Installation d'Exhaure des Mines de l'Horcajo). Describing the system of high-pressure centrifugal pumps arranged in series, for draining the silver-lead mines of Horcajo, Spain. 2500 w. Génie Civil—Aug. 16, 1902. No. 50720 D.

Mining Cartridge.

The Hydraulic Mining Cartridge. James Tonge, Jr. Awarded the Benjamin Shaw prize for industrial hygiene. A description of an appliance for breaking down coal in mines without the use of explosives, and of the mode of working. 2000 w. Jour Soc of Arts—Sept. 5, 1902. No. 50553 A.

Mining Law.

Senator Kearns's New Mining Law. R. W. Raymond. Discussion of a bill to come before the U. S. Congress at the next session. 1700 w. Eng & Min Jour—Sept. 6, 1902. No. 50422.

Output.

Recording the Output of a Mine. Charles V. Jenkins. Describes a system of securing detailed record of ore production, distinguishing shipments, and identifying returns. 4200 w. Mines & Min—Sept., 1902. No. 50511 C.

Ore Handling.

Hoover & Mason Ore Handling Plant at South Chicago, Ill. Illustrates and describes the ore-unloading plant at the South Chicago works of the Illinois Steel Company. 2500 w. Ir Trd Rev—Sept. 4, 1902. No. 50381.

See Electrical Engineering, Power Applications.

Rock Drills.

The Progress of Rock Drilling in 1902 (Die Gesteinbohrmaschinenfrage im Jahre 1902). Th. Giller. A comparison of the relative advantages of compressed air and electricity, showing that the best results are to be expected from their combination 3000 w. Glückauf—Aug. 30, 1902. No. 50742 B.

Safety Brake.

The Blosfeld Safety Brake for Winding Engines. Hr. Ansorge, in *Zeitschrift für Berg-, Hütten-, und Salinenwesen.* Illustrates and describes a brake intended to supplement the ordinary brake in an emergency. 1200 w. Col Guard—Sept. 19, 1902. No. 50811 A.

Shaft Sinking.

A New System of Sinking Shafts. Illustrates and describes a method suited to all kinds of soil, devised by the Hardy Patent Pick Co., of Sheffield, England. It claims speed of boring, and immunity from accident. 900 w. Sci Am—Sept. 6, 1902. No. 50403.

Steel Lining Mine at "B" Shaft, Pioneer Mine, Minnesota. Frank Drake. Read at meeting of Lake Superior Mining Inst. Abstract of a paper on the use of steel in lining mine shafts. Ill. 2200 w. Eng & Min Jour—Sept. 13, 1902. No. 50542.

Slate.

The Underground Slate Workings of France. Illustrates and describes methods of operating at Angers and at Ardennes, and gives information from a recent work by Mr. Watrin, Chief Inspector of Mines at Mézières. 2000 w. Stone—June, 1902. No. 50479 C.

Transvaal.

The New Deep-Level Mines in the Transvaal. Notes from the special commissioner of the London *Economist.* Considers some questions involved in working the deep ground. 1200 w. Eng & Min Jour—Sept. 20, 1902. No. 50651.

Witwatersrand.

The Preservation of Life in the Witwatersrand Mines. T. Lane Carter. States the causes of the mortality and suggests remedies. 1500 w. Eng & Min Jour—Aug. 30, 1902. No. 50309.

MISCELLANY.

Aluminum.

Aluminum. The first of a series of articles on its history and metallurgy. 1800 w. Aust Min Stand—July 24, 1902. Serial. 1st part. No. 50333 B.

Contributions to the Study of the Alloys of Aluminum (Contributions à l'Étude des Alliages d'Aluminum). Léon Guillet. Discussing alloys with tungsten, molybdenum, copper, tin, titanium, iron, manganese, nickel, etc., and their chemical and physical properties. 15000 w. Bull Soc d'Encour—Aug 31, 1902. No. 50734 G.

See Electrical Engineering, Electro-Chemistry.

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Arsenic.

The Recovery of Aresnic from Ores and Metallurgical By-Products. Herbert Haas. Illustrated description of a roasting furnace and its operation. 1000 w. Mining & Sci Pr—Sept. 6, 1902. No. 50495.

Düsseldorf Exposition.

Metallurgy at the Düsseldorf Exposition, 1902 (Der Bergbau auf der Düsseldorfer Austellung 1902). H. Beckert. A review of the iron working exhibits, products, and methods shown at the Düsseldorf exposition. Two articles. 1 plate. 6000 w. Glückauf—Aug. 16, 23, 1902. No. 50740 each B.

Gypsum.

Present and Future of the American Gypsum Industry. Frank A. Wilder. An illustrated article stating the localities in the United States where it is found, the causes of the deposits, the uses, etc. 3000 w. Eng & Min Jour—Aug. 30, 1902. No. 50308.

Nickel.

The Sulphide Ore Bodies of the Sudbury Region. L. P. Silver. Describes these deposits which are the source of over forty-five per cent. of the present nickel production of the world. Ill. 5600 w. Can Min Rev—Aug. 30, 1902. No. 50297 B.

Oil Fields.

The Beaumont Oil Field, with Notes on Other Oil-Fields of the Texas Region. Robert T. Hill. Considers the geological interpretation of oil phenomena, describing the geography of this region, the geology, the different fields, composition of the oil, development, etc., offering an explanatory hypothesis. Ill. 15600 w. Trans Am Inst of Min Engrs—Sept., 1902. No. 50683 D.

Petroleum.

Diatom-Earth in Arizona. W. P. Blake. Describes these deposits, and discusses their origin and as a possible source of petroleum. 2800 w. Trans Am Inst of Min Engrs—Sept., 1902. No. 50685 C.

Phosphate.

The Phosphate-Rock Discovery in Otago. James Park. Describes the physical and geological features, the deposits, etc. 3500 w. N Z Mines Rec—Aug. 16, 1902. No. 50605 B.

Precious Stones.

How to Identify Precious Stones. Describes methods of testing. 2000 w. Min & Sci Pr—Aug. 23, 1902. No. 50239.

Quarries.

The Sandstone Quarries of Saxony and Silesia. An illustrated description of these quarries, methods of working, geology, etc. 3000 w. Quarry—Sept. 1, 1902. No. 50464 A.

Quicksilver.

The Cinnabar Deposits of the Big Bend Province of Texas. Robert T. Hill. Information concerning these deposits, especially their nature and geology. Map. 4000 w. Eng & Min Jour—Sept. 6, 1902. No. 50423.

Turquoise.

Turquoise Mining in Arizona and New Mexico. An illustrated article describing the deposits, the formation in which turquoise is found, methods of mining, etc. 1800 w. Min & Sci Pr—Aug. 23, 1902. No. 50240.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in July. Condensed record of the principal accidents. 3000 w. R R Gaz—Sept. 5, 1902. No. 50391.

Train Accidents in the United States in August. Condensed record with remarks. 4000 w. R R Gaz—Sept. 26, 1902. No. 50808.

Employees.

English and American Railroad Employees. Editorial discussion of the conditions affecting railroad transportation in the two countries. 2800 w. R R Gaz—Sept. 5, 1902. No. 50393.

Rapid Transit.

Shortening Time Across the Continent. Henry Herbert McClure. Discussing the improved railway service in the United States, especially the twenty-hour train established between New York and Chicago. 1800 w. Nat Geog Mag—Aug., 1902. No. 50289 C.

Train Service.

British and French Summer Train Services in 1902. Charles Rous-Marten. Reviewing what has been done during the current season in the way of improvements. 2000 w. Engr, Lond—Aug. 22, 1902. No. 50362 A.

FINANCIAL.

Railroad Capitalization.

The Value of the Railroads and Their Capitalization. H. T. Newcomb, in the *Yale Review*, August. Some notes on

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capitalization statistics. 1400 w. R R Gaz —Aug. 29, 1902. No. 50274.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Proper Air Brake Instructions to All Concerned to Prevent the Ruination of Wheels by Skidding, and Handling of Air on Freight Trains. Abstract of a committee report to the Traveling Engineers' Assn. with brief discussion. 2000 w. Ry Age—Sept. 19, 1902. No. 50656.

Axles.

Graphical Method of Finding Limit Diameters for Car and Tender Axles. R. B. Kendig. Gives a diagram and explains its use. 800 w. Am Engr & R R Jour—Sept., 1902. No. 50412 C.

Cars.

90,000-Pounds Capacity Gondola Car. Illustrates and describes a car with steel draft frame and roller side bearings built for the L. S. & M. S. Ry. 300 w. Am Engr & R R Jour—Sept., 1902. No. 50408 C.

Coal Car.

50-Ton Steel Coal Car, with Westinghouse Friction Draft Gear; Pennsylvania R. R. Illustrates and describes the construction of these cars and compares them with some others of the same class built by the same firm for other railways. 1800 w. Eng News—Sept. 4, 1902. No. 50395.

Headlights.

Headlight with a Vertical Beam. Illustrates and describes a new type of electric headlight which in addition to sending a powerful ray along the tracks, also projects a vertical beam. 1200 w. Sci Am—Sept. 13, 1902. No. 50489.

Locomotive Boilers.

The Care and Management of the Locomotive Boiler. Thomas J. Rossell. On the advantages gained by keeping the boiler and flues clean, and concerning the rapidity with which the work may be done by devices invented by the writer. 900 w. Loc Engng—Sept., 1902. No. 50417 C.

Locomotives.

Atlantic Type Passenger Engines for the Chesapeake & Ohio. Illustrations and general dimensions. 250 w. R R Gaz—Sept. 12, 1902. No. 50516.

Baldwin Fast Freight Ten-Wheel Engine for the Northern Pacific. Illustrated description of a type of which forty have recently been ordered. 900 w. Loc Engng—Sept., 1902. No. 50415 C.

Express Compound Locomotive, Austrian State Railways. Illustration and description of the fine two-cylinder four-coupled locomotive employed for the fast international train services. 800 w. Engr, Lond—Sept. 12, 1902. No. 50630 A.

Goods Engine, Cape Government Railways. Illustrated description of a narrow-gauge locomotive, embodying the latest improvements on engines of this type. 900 w. Engr, Lond—Sept. 5 1902. No. 50568 A.

New Six-Coupled Passenger Locomotives. Gives general plans of two new engines of this type, one for the C. & O. Ry. and the other for the M. P. Ry. Comparisons may be made by aid of the drawings and information given. 800 w. Am Engr & R R Jour—Sept., 1902. No. 50410 C.

Passenger Locomotives for the National Railroad of Mexico. General description with illustrations. 500 w. R R Gaz—Aug. 29, 1902. No. 50275.

Six-Wheeled Coupled Passenger Locomotive; Caledonian Railway. Illustrated description of a locomotive designed for heavy gradients and sharp curves. 400 w. Engng—Aug. 29, 1902. No. 50470 A.

Some New Engines for the Chicago and Alton. Gives erecting card and principal dimensions of simple consolidation engines. 600 w. R R Gaz—Sept. 5, 1902. No. 50392.

Tandem Compound Consolidation Locomotives for the Erie R. R. Half-tone engraving, elevation, and sectional views, with description. 1000 w. Ry & Engng Rev—Aug. 30, 1902. No. 50294.

Tank Locomotive for Suburban Traffic, Northern Railway of France. Illustrated description of a new type of tank locomotive for service between Paris and towns within 50 miles. 500 w. Engng—Sept. 12, 1902. No. 50635 A.

The de Glehn Four-Cylinder Compound. A. G. de Glehn. A discussion of the construction of this type of engine answering arguments that have been used to oppose it. 2600 w. Am Engr & R R Jour —Sept., 1902. No. 50407 C.

The Hayes Ten-Wheel Camel. C. H. Caruthers. Illustration with brief description of engines in service in 1853. 600 w. Loc Engng—Sept., 1902. No. 50416 C.

The Proper Handling of Compound Locomotives. Abstract of a paper by W. J. McCarroll read before the Trav. Engrs. Assn. Suggestions for handling compounds as they are at present constructed. 2500 w. R R Gaz—Sept. 26, 1902. No. 50807.

Locomotive Trade.

See Industrial Economics.

Smoke Consumer.

A New Locomotive Fuel Economizer and Smoke Consumer. Illustrated detailed description of the new smoke consumers being placed on the locomotives of the N. Y. C. & H. R. R. R. 1100 w. Eng News—Aug. 28. 1902. No. 50269.

We supply copies of these articles. See page 325.

Tires.

Methods of Fastening Tires to Car Wheels (Zur Radreifenbefestigung). Alois Schaffer. A study of the various methods of keying and securing tires to the wheels of railway vehicles, including the use of impact tools for upsetting the edge of the tire into the wheel rim. 4000 w. Oesterr Wochenschr f d Oeffent Baudienst—Sept. 13, 1902. No. 50747 B.

Wear of Steel Tires in Germany. Reviews a recent summary of the report on the wear of steel tires on German railroads. 4400 w. R R Gaz—Sept. 12, 1902. No. 50519.

Traction.

Tractive-Power Formulae. George F. Summers. Gives approximate formulae arranged for the purpose of basing one engine upon experience with another. 700 w. Am Engr & R R Jour—Sept., 1902. No. 50411 C.

Train Lighting.

The Electric Lighting of Corridor Trains on the Prussian State Railways. (Die Elektrische Beleuchtung einiger D-Züge der Preussischen Staatsbahn-Verwaltung) H. Wichert. Describing the use of the de Laval steam turbine, driving a dynamo mounted on the locomotive, for producing current for electric lighting of railway trains. 5000 w. Glasers Annalen—Aug. 15, 1902. No. 50715 D.

The Lighting of Railway Trains in Continental Europe. Henri Guérin. A systematic account of train lighting systems on the Continent, including oil, gas, acetylene, and electricity. 3500 w. Engineering Magazine—October, 1902. No. 50786 B.

NEW PROJECTS.

Pennsylvania Railroad.

The Pennsylvania Railroad in New York. An article by H. G. Prout, printed in the *N. Y. Times*. A sketch map of the new line across New York city, a discussion of the great undertaking and its object. 1500 w. R R Gaz—Sept. 19, 1902. No. 50594.

PERMANENT WAY AND BUILDINGS.

Detour.

The Pennsylvania Railroad in New York Central & Hudson River Railroad. Alignment, profile and brief description of an important improvement saving a heavy grade and the passage of many trains through the city at the street level. 350 w. R R Gaz—Sept. 19, 1902. No. 50593.

Locomotive House.

The Locomotive House of the Austrian State Railways at Knittelfeld (Heizhaus Knittelfeld der K. K. Oesterreichischen Staatsbahnen). Oskar Rother. With description of round house, coaling plant, and general mechanical installation. 3500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Aug. 30, 1902. No. 50745 B.

Mountain Railways.

Remarkable Engineering Feats in Railroad Work. Charles F. Holder. Brief illustrated description of the road at Mt. Tamalpais, north of San Francisco, and the bridge across Cañon Diablo. 700 w. Sci Am—Aug. 30, 1902. No. 50242.

Oil Storage.

Oil-Storage Station. Illustrated description of the oil-storage station of the Hoosic tunnel on the Boston & Maine R. R. 1500 w. Am Engr & R R Jour—Sept., 1902. No. 50409 C.

Shops.

Michigan Central Shop Improvements at Jackson, Mich. An illustrated description of improvements being made which include a new central power and lighting station, and the building of a large addition to the machine and erecting shop. 2300 w. R R Gaz—Sept. 19, 1902. No. 50591.

Shop Improvements on the Southern California R. R. Illustrates and describes the enlargement and extension of these shops at San Bernardino, Cal. 1100 w. R R Gaz—Aug. 29, 1902. No. 50273.

Signalling.

Harrison Street Low-Pressure Pneumatic Interlocking. Brief illustrated description of a plant installed in Chicago. 600 w. R R Gaz—Sept. 19, 1902. No. 50592.

The Development of Railway Signalling. W. P. Digby. An illustrated article reviewing the various improvements in railway signalling. 2400 w. Transport—Sept. 5, 1902. No. 50550 A.

Stations.

Improvements at the St. Paul Union Depot. Abstract of a report submitted by Henry M. Sperry, describing these improvements which will greatly increase the facilities of this station. 2000 w. R R Gaz—Aug. 29, 1902. No. 50272.

Terminals.

The Proper Method of Counting Cars Handled Over Terminals in Figuring Cost of Handling Per Car. R. V. Miller. Gives a few of the methods of counting cars and the method recommended by the writer. 3000 w. St. Louis Ry Club—Aug. 6, 1902. No. 50283.

Tracks.

Some Advice on Track Work. Extracts from an address by W. L. Park to the roadmasters and section foremen on a

division of the Union Pacific R. R. 1700 w. Ry & Engng Rev—Sept. 6, 1902. No. 50421.

Tunnels.

See Civil Engineering, Construction.

MISCELLANY.

Düsseldorf Exposition.

Railway and Transportation Exhibits (Das Eisenbahn und Verkehrswesen). M. Buhle. The first of a series of illustrated articles describing in detail the exhibits of railway material and appliances at Düsseldorf in 1902. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing—Aug. 16, 1902. No. 50701 D.

Europe.

European Railway Notes. Angus Sinclair. Principally discussing customs in Great Britain. 1800 w. Loc Engng—Sept., 1902. No. 50419 C.

Great Britain.

Board of Trade Control Over Railroads in Great Britain. H. Raynor Wilson. An explanation of what this control consists and how the power is exercised. 5200 w. R R Gaz—Sept. 5, 1902. Serial. 1st part. No. 50389.

STREET AND ELECTRIC RAILWAYS

Acceleration.

The Increased Acceleration on the Liverpool Overhead Railway. A description of the equipment being installed to obtain very high acceleration to meet competition. 2000 w. Tram & Ry Wld—Sept. 11, 1902. No. 50802 B.

Accidents.

Accidents on Electric Railroads. C. R. Barnes. Read before the convention of the N. Y. State Ry. Assn. Discusses various classes of accidents and their causes, and matters of related interest. 3200 w. St Ry Jour—Sept. 13, 1902. Serial. 1st part. No. 50536 D.

Accidents on Street Railways from the Legal Point of View. Joseph F. Daly. Read at Caldwell meeting of the N. Y. State St. Ry. Assn. Discusses the immense number of cases to be dealt with by the courts, and the steps necessary for relief of the courts, so as not to unduly delay other cases. 3800 w. St Ry Jour—Sept. 20. 1902. No. 50661 D.

President Roosevelt in a Trolley Accident. An illustrated article giving as accurate a statement of the facts as is now obtainable. 1200 w. St Ry Jour—Sept. 13, 1902. No. 50529 D.

The Handling of Accident Claims. William A. Dibbs. Read before the N. Y. St. Ry. Convention. Describes methods of dealing with such claims. 2400 w. St Ry Jour—Sept. 13, 1902. No. 50534 D.

Birkdale.

Electricity for Birkdale. Illustrates and describes a new generating station erected to supply electricity for tramways and lighting. 3200 w. Tram & Ry Wld—Sept. 11, 1902. No. 50803 B.

Brakes.

Brakes for Tram Cars. C. J. Spencer. Read before the Assn. of Munic. Tram. Mgrs. Discusses the question of brakes, reporting tests made of the slipper brake. 2500 w. Tram & Ry Wld—Aug. 7, 1902. No. 50264 B.

Cars.

Cars for the New York Subway. An illustrated description of two experimental cars built as samples for use in the subway. Also comparison with the Manhattan Elevated cars. 1200 w. St Ry Jour—Sept. 20. 1902. No. 50659 D.

Conduit System.

Conduit Electric Tramways. Illustrated description of the reconstruction of the Tooting lines of the London County Council Tramways. 4600 w. Tram & Ry Wld—Sept. 11, 1902. No. 50800 B.

New Conduit Work of the Brussels Tramway Company. Illustrated description of work being carried out. The conduit is laid under one of the rails, instead of between the rails, as in America. 2500 w. St Ry Jour—Sept. 6. 1902. No. 50380 D.

Curves.

A Graphical Method of Making Time-Speed Curves. Walter S. Valentine. Describes a method devised by the writer which greatly facilitates the construction of these curves. 1400 w. St Ry Jour—Sept. 6, 1902. No. 50377 D.

Discipline.

Discipline. C. B. Fairchild. Read at convention of the N. Y. State St. Ry. Assn. A discussion of matters relating to the proper discipline of employees. 5000 w. St Ry Jour—Sept. 13, 1902. No. 50535 D.

Electric Locomotive.

Electric Locomotive for Freight and Industrial Service. Remarks on the class of work for which these locomotives are

We supply copies of these articles. See page 325.

adapted, with illustrated descriptions of recent installations. 1400 w. St Ry Jour—Sept. 13, 1902. No. 50531 D.

England.

The Electrification of Our Railways. A discussion of what has been done and ought to be done in London and suburbs especially, criticising the attitude of the railway companies. 3700 w. Elec Rev, Lond—Aug. 22, 1902. No. 50353 A.

Expenses.

Operating Expenses. J. B. Hamilton. Read before the Munic. Tram. Mgrs. Assn. Notes regarding practice on some American tramway systems. 2800 w. Tram & Ry Wld—Aug. 7, 1902. No. 50265 B.

Halifax.

The Tramway System of Halifax, England. An illustrated article giving particulars of the system and its power equipment. 3500 w. St Ry Jour—Sept. 6, 1902. No. 50375 D.

High Speed.

A Critical Review of the High-Speed Electric Trains at Zossen. Robert Grimshaw. 3000 w. Sci Am Sup—Sept. 6, 1902. No. 50406.

Highways.

Relation between Macadam Roads and Electric Street Railways. Edward P. North. Read at the Good Roads convention. Discusses the effect of electric railways in developing country districts and their influence on road maintenance. 1500 w. Eng Rec—Sept. 13, 1902. No. 50525.

Street Railways and State Highways. Harold Parker. Remarks referring especially to Massachusetts. 1800 w. Jour Assn of Engng Socs—Aug., 1902. No. 50692 C.

Improvements.

Recent Improvements on the Metropolitan Railway of Paris. Describes and illustrates the two-motor car train system recently installed on this underground electric road. 1400 w. St Ry Jour—Sept. 6, 1902. No. 50378 D.

Interurban.

An Important Interurban Road in Southern Ohio. Illustrated description of an interurban road 39.5 miles long, connecting Dayton and Greenville, Ohio, its equipment, operation, etc. 4500 w. St Ry Jour—Sept. 6, 1902. No. 50379 D.

Car Dispatching on Interurban Lines. Thomas E. Mitten. Read at convention of the N. Y. State St. Ry. Assn. An explanation of a system devised by the writer which, while similar to steam railway practice, is more flexible and simple. 3000 w. St Ry Jour—Sept. 20, 1902. No. 50662 D.

The Aurora, Elgin & Chicago Interurban Railway. An illustrated description of a recently opened road extending west from Chicago, which is a good example of recent construction. 2200 w. R R Gaz—Sept. 26, 1902. No. 50806.

Track and Overhead System for an Interurban Electric Railway. Gilbert Hodges. A discussion of road bed and track work and the construction of an overhead electric system. 3800 w. Jour Assn of Engng Socs—Aug., 1902. No. 50691 C.

Legislation.

A Session of Tramway Legislation. Herbert M. Adler. Discusses some of the more important schemes sanctioned by the British Parliament in 1892, and considers the measures passed in the last session of Parliament. 2000 w. Engng—Aug. 22, 1902. Serial. 1st part. No. 50374 A.

Legal Decisions.

The Law of Master and Servant in Relation to Tramway Companies. J. Neville Porter. A report of several interesting decisions in the British courts. 2500 w. Tram & Ry Wld—Sept. 11, 1902. Serial. 1st part. No. 50805 B.

New York.

Street Railway Situation in New York. G. Tracy Rogers. Presidential address at Caldwell meeting of the St. Ry. Assn. of the State of N. Y. 4000 w. St Ry Jour—Sept. 13, 1902. No. 50532 D.

Power Station.

New Power Station and Car House at Manchester, England. An illustrated article giving particulars of interest in regard to the new Stuart Street works, which combines under one roof two complete stations of considerably different design. 2500 w. St Ry Jour—Sept. 6, 1902. No. 50376 D.

New Power Stations of the Boston Elevated Railway. Illustrates and describes the Charlestown station, and the Lincoln Wharf station, giving information of interest. 4800 w. Engr, U S A—Sept. 1, 1902. No. 50280.

Providence, R. I.

The Street Railway System of Providence, Rhode Island, and Vicinity. George B. Francis. An illustrated article giving an account of this system. Also discussion. 3000 w. Jour Assn of Engng Socs—Aug., 1902. No. 50688 C.

Rail Joints.

Electric Welding of Rail Joints. An illustrated description of the machines used and methods of operation. 700 w. Ir Age—Sept. 25, 1902. No. 50668.

Rapid Transit.

The Rapid Transit Subway, New York. An illustrated article showing the method of carrying the electric tracks, with plan showing the progress of the entire work,

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and remarks on the engineering difficulties due to the conditions. 2100 w. Sci Am —Sept. 27, 1902. No. 50699.

Rolling Stock.

Tramway Rolling Stock. The first of a series of illustrated articles giving a general outline of various types of rolling stock. 2800 w. Tram & Ry Wld—Sept. 11, 1902. Serial. 1st part. No. 50804 B.

Single Phase.

Single-Phase Equipment for Washington, Baltimore & Annapolis Interurban Railway. Brief description of the equipment with single-phase alternating-current apparatus. 900 w. St Ry Jour—Sept. 13, 1902. No. 50530 D.

Snow Handling.

Removal of Snow and Ice in the Borough of Manhattan. W. Boardman Reed. Read at convention of the N. Y. State St. Ry. Assn. An account of the methods used in New York city to keep the tracks and streets clear of snow. 2000 w. St Ry Jour—Sept. 13, 1902. No. 50533 D.

Station.

Large Interurban Terminal Station in Cincinnati. Illustrated description of a building being erected by the Interurban Terminal Company. 800 w. St Ry Jour —Aug. 30, 1902. No. 50276.

The Aurora, Elgin & Chicago Railway Power Plant. An illustrated detailed description of a new generating station and its equipment. 3400 w. Steam Engng—Sept. 10, 1902. No. 50560.

Tracks.

Street Railway Track Construction in City Streets. Arthur L. Plimpton. Mainly an illustrated description of the track construction of the Boston Elevated Railway Company's system. Also discussion. 4800 w. Jour Assn of Engng Socs—Aug., 1902. No. 50689 C.

The Relation of Street Railway Tracks to the Paving of City Streets. Henry Manley. Considers points in which the tracks affect the maintenance of the street surface. 1200 w. Jour Assn of Engng Socs—Aug., 1902. No. 50690 C.

The Track Construction of Suburban and Interurban Electric Railways. S. S. Hoff. Read at meeting of the Penn. St. Ry. Assn. Discusses principally points relating to the construction through private property. 2700 w. St Ry Jour—Sept. 20, 1902. No. 50663 D.

The Track Construction of Suburban and Interurban Electric Railways. S. S. Hoff. Read before the Penn. St. Ry. Assn. Considers especially the construction through private property, discussing details. 2500 w. Elec Rev, N Y—Sept. 27, 1902. No. 50839.

Track Department of the Detroit United Railway. Illustrates and describes the interesting features of the work done by this department of a road now operating about 390 miles of track. Also describes the distribution system and overhead construction. 4000 w. St Ry Rev—Sept. 20, 1902. No. 50907 C.

Tracks in Tunnels. George Hebard Paine. Considers track construction with a view to determining the best for the traffic in the New York subways. Ill. 900 w. R R Gaz—Sept. 12, 1902. No. 50518.

Traffic.

Some Traffic Problems. C. R. Bellamy. Read before the Assn. of Munic. Tram. Mgrs. Discusses a few of the important problems in connection with the working of municipal tramways. 2200 w. Tram & Ry Wld—Aug. 7, 1902. No. 50263 B.

Train Staff.

The Train Staff for Electric Railroads. Editorial discussing the views of H. D. Emerson as given in the *Street Railway Journal*, advocating the use of the "train staff" in single-track interurban electric railroads. 1600 w. R R Gaz—Sept. 19, 1902. No. 50595.

Transporters.

Electric Truck for Carrying Standard Gauge Cars on Narrow Gauge Railways (Transporteur Electrique de Wagons à Voie Normal sur les Voies Etroites). A. Taveau. Illustrated description of an electrically propelled platform truck arranged to carry standard freight cars upon narrow gauge railways. 1800 w. 1 plate. Génie Civil—Aug. 23, 1902. No. 50721 D.

Wagon Transporters. From *Le Genie Civil.* Illustrated detailed description of transporters for carrying cars of large gauge over lines of smaller gauge, which have quite recently been experimented with at Rheims. 1200 w. Engr, Lond—Sept. 12, 1902. No. 50631 A.

Underground.

Underground Tube Railways. P. V. McMahon. Read before the International Tramways Congress. Compares the tube railway and the shallow tunnel tramway, discusses the general conditions, giving a brief description of the existing tubes in London and a few results of their working. 3600 w. Tram & Ry Wld—Aug. 7, 1902. No. 50262 B.

Warrington.

Electric Tramways at Warrington. Illustrated description of the tramway construction in this English town. Current for lighting and power will be furnished and a destructor plant is connected. 3600 w. Tram & Ry Wld—Sept. 11, 1902. No. 50801 B.

Yarmouth.

Yarmouth Tramways. An illustrated detailed account of the municipal tramways of Great Yarmouth, Eng. 4000 w. Elec Engr, Lond—Aug. 22, 1902. No. 50349 A.

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EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manuf. and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.

Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineering. *w.* London.
Enginering and Mining Journal. *w.* New York.
Enginering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Straussenbahnen. *s-m* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallographist. *qr.* Boston.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Procedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'Way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* New York.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining. Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post-Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Aerial Navigation.

Aerial Navigation. A Practical Handbook on the Construction of Dirigible Balloons, Aerostats, Aeroplanes and Aeromotors. By Frederick Walker, C. E. Size, 8 in. by 5 in.; pp. XVI, 151; figures, 105. Price, $3.00. New York: D. Van Nostrand Company. London: Crosby, Lockwood and Son.

This book reviews the present state of the art of aerial navigation. In the first chapter the laws of flight are discussed, with practical illustrations of the wings of birds, bats and insects. Other chapters treat of aerostatics, aerodynamics, methods of propulsion, motive power and engines, and the structure and materials of air-ships. An important part of the volume is devoted to the actual embodiments of the different principles discussed, and most of the leading aerostats, aeroplanes and air-ships are illustrated and described, some in considerable detail.

Bridge Design.

A Text Book of Roofs and Bridges. Part III. Bridge Design. By Mansfield Merriman and Henry S. Jacoby. Size, 9 in. by 6 in.; pp. VIII, 374; figures, 149; plates, 7. Price, $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

In the present fourth edition, this standard text book has been entirely rewritten and brought fully up to date, in order to keep it abreast of modern bridge design, which has undergone remarkable changes in recent years. The new design of girders and simple trusses conform to the latest specifications and the best practice, and numerous new standard details are described. This volume is confined to simple bridges, or those resting on two supports, other forms being discussed in a subsequent part of the series. The theory of stresses in simple trusses is laid down in still another volume, but the present work gives a very practical and complete treatment of the detailed design of bridges. Among others the chapters on bridge contracts and office work and on bridge shops and shop practice give information of the greatest practical importance, but which is too often neglected in college courses. Altogether, this work is a most useful one, particularly for students and young engineers.

Copper.

The Copper Handbook. A Manual of the Copper Industry of the United States and Foreign Countries. Vol. II. By Horace J. Stevens. Size, 8½ in. by 5¾ in.; pp., 416. Price, $1 (paper); $2 (buckram); $3 (full morocco). Houghton, Mich.: Horace J. Stevens.

This is the 1902 edition of a work devoted entirely to copper and first published in 1900. The present edition has been greatly enlarged and its scope extended, its ten chapters treating, respectively, of the history of copper; chemistry and mineralogy of copper; metallurgy of copper; a glossary of mining terms; copper deposits of the world; copper deposits of the United States; leading foreign mines; Lake Superior copper mines; other United States copper mines; and statistics of copper. All the principal copper mines of the world are described in more or less detail, the account of the Lake Superior district being particularly full. The statistics include those of production, consumption, export and import, finance, etc., and have been brought up to date. The book contains a vast amount of useful information, systematically arranged, and is extremely valuable for any one interested in copper.

Kinematics.

Traité de Cinématique Théorique. By H. Sicard, with notes by A. Labrousse. Size, 10 in. by 6½ in.; pp. VIII, 185; figures, 100. Paper covers. Paris: Gauthier-Villars.

This book, written by two professors of mathematics, contains all the essentials of theoretical kinematics. It is fully illustrated by diagrams, and is written and arranged in the clear and elegant French mathematical style.

Materials of Machines.

Materials of Machines. By Albert W. Smith. Size, 7½ in. by 5 in.; pp. 142; figures, 17. Price, $1.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

This book, as stated in the prefatory note, "is a result of an effort to bring together concisely the information necessary to him who has to select materials for machine parts," and the author, who is the professor of mechanical engineering

in Leland Stanford Junior University, has succeeded remarkably well in attaining his object. There is a clear outline of the metallurgy of iron and steel and of testing, after which the various metals and alloys which enter into the construction of machines are discussed in detail, and the most suitable materials for different parts of machines are indicated. There are many large treatises on the resistance of material in general and others on machine design in general, but the present little volume combines in a happy degree the essentials of the larger works which concern its immediate subject.

Mineral Industry.

The Mineral Industry, Its Statistics, Technology and Trade in the United States and Other Countries to the End of 1901. Vol. X. Edited by Joseph Struthers, Ph. D. Size, 9½ in. by 6½ in.; pp. XXX., 920; figures, diagrams and tables. Price, $5.00 (£1, 10d.) New York and London: The Engineering and Mining Journal (Inc.)

The present volume supplements the preceding nine volumes of the series founded by the late Richard P. Rothwell, and, as such, needs no introduction to the mineral and metal world. This encyclopedic work has become such a well-recognized institution that it is its own best advocate, and praise seems superfluous. It may be said, however, that in this latest volume the high standard formerly established has been maintained, and the new editor is to be heartily congratulated on the result of his labors, which can be fully appreciated only by those who have worked in neighboring fields. As is well known, the various mineral and metallurgical products of the world are taken up in alphabetical order, statistics given of their amount and cost of production, their prices, etc., new fields and processes are described and all other available information concerning them is brought up to date. There are also sections devoted to special subjects, such as pyritic smelting, metallography, mine timbering and support of earthworks, alloys as solutions, ore dressing, liquefied carbonic acid gas and the Wetherill system of magnetic concentration. Many of the foremost specialists in their respective lines have contributed signed articles to this book, which, together with its predecessors, forms an up-to-date encyclopedia of the broad subject covered by its title, and is absolutely indispensable to every one interested in the mineral and metal industries.

Steel Specifications.

Review and Text of the American Standard Specifications for Steel. By Albert Ladd Colby. Size, 7 in. by 5 in.; pp. 103; figures, 2. Price, $1.10. Easton, Pa.: The Chemical Publishing Co.

This book contains the revised text of the standard specifications for steel, adopted by the American Section of the International Association for Testing Materials, on August 10, 1901, this section, by the way, being now entirely separate from the international body. There are nine sets of specifications, those, namely, for castings, axles, forgings, tires, rails, splice bars, structural steel for buildings, structural steel for bridges and ships, and open-hearth boiler plate and rivet steel. The author reviews these specifications critically and gives the reasons which governed the drafting committee, of which he was a member, in its decisions. The specifications are practical and are the result of an effort to harmonize all interests. They are not intended to cover every specific purpose, but will serve for the majority of uses to which steel is applied, and can be modified to suit particular requirements without departing materially from the standard form and practice recommended.

Steel Treatment.

The Treatment of Steel. Size, 7 in. by 5 in.; pp. 162; figures, 6; plate, 1. Price, $1.00. Pittsburg, Pa.: Crucible Steel Company of America.

This is the third edition of a compilation from the publications of the Crescent Steel Company on heating, annealing, forging, hardening and tempering and on the use of furnaces. It also has a chapter on hardening and tempering from a work by George Ede, of Woolwich Arsenal, and one on "Why Does Steel Harden?" by W. Metcalf. This book is attractively gotten up and contains many useful and practical hints for steel makers.

BOOKS ANNOUNCED.

The Engineer's Sketch-Book of Mechanical Movements, Devices, Appliances, Contrivances and Details Employed in the Design and Construction of Machinery for Every Purpose. 4th ed. By Fred. Walter Barber. Pp. 335. $4. New York: Spon & Chamberlain.

Self-Propelled Vehicles: A Practical Treatise on the Theory, Construction, Operation, Care and Management of all Forms of Automobiles. By James E. Homans. Pp. VI, 632; ill. $5. New York: Theodore Audel & Co.

Slide Valve Instruction Chart, Showing the Various Positions of the Crank Pin, Eccentric and Piston at the Point of Admission, Lead and Cut-Off. By Jos. Phinney Lisk. Size, 11 in. by 14½ in. 25 cents. New York: Spon & Chamberlain.

Tunneling: A Practical Treatise. 2nd edition. By Charles Prelini, with additions by Charles S. Hill. Pp. VI, 325; ill. $3. New York: D Van Nostrand Co.

NEWS SUPPLEMENT

The Engineering Magazine—November, 1902

Coming Society Meetings.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. Sec.: Prof. L. O. Howard, Cosmos Club, Washington, D. C. Annual meeting, Dec. 29 to Jan. 3, Washington.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Regular meeting on fourth Friday of each month, 12 W. 31st St., New York.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION. Sec.: L. C. Fritch, Cincinnati. Annual meeting, March, 1903.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month. Annual meeting, Jan. 21 and 22, 1903.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Semi-annual meeting, Dec. 2-5.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except January, when on fourth Wednesday.

CANADIAN RAILWAY CLUB. Sec.: M. P. Kelly, Montreal. Regular metings on second Tuesday of each month.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. Regular meetings, Nov. 6, 20 and every alternate Thursday. Annual meeting, Jan. 8, 1903.

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Fridays of Nov., Jan., March, May and Sept., Hotel Iroquois, Buffalo.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. J. Warder, Jr., 900 Warren Ave. Regular meetings on first Friday of each month.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Arthur A. Skeels, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: H. M. Jones, 1000 Broad St., Nashville, Tenn. Regular meetings on second Thursday of each month, at Vanderbilt University.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: J. F. Wilson, P. O. Box 333. Regular meetings on third Thursday of each month.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec.: H. M. Gates, 12½ North High St. Regular meetings on first and third Saturdays of each month.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Edw. P. Burch, 1210 Guaranty Bldg. Regular meetings on third Monday of each month.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: L. F. Rondinella, 1122 Girard St. Regular meetings on first and third Saturdays of each month.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: D. W. Roper, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

ENGINEERS' SOCIETY OF WESTERN NEW YORK. Sec.: George T. Roberts, 975 Ellicott Square, Buffalo. Regular meetings, first Tuesday of each month.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month. Regular monthly meetings of the various sections on other days.

IOWA RAILROAD CLUB. Sec.: J. A. Wagner, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 712 Union St., New Orleans. Regular meetings on the second Monday of each month.

MONTANA SOCIETY OF ENGINEERS. Sec.: Richard R. Vail, Butte, Mont. Regular meetings on second Saturday in each month.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Sec.: James B. Cahoon, 136 Liberty St., New York. Meeting, May, 1903, Chicago.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month at Pierce Hall, Copley Square.

NEW YORK RAILROAD CLUB. Sec.: W. B. Yereance, 168 Montague St., Brooklyn. Regular meetings on third Thursday of each month, at 349 Madison Ave., New York.

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, alternating between Minneapolis and St. Paul.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS. Sec.: Corwin J. Miller, Canton, O. Meeting, Nov. 15, Canton, O.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Barton, West Oakland, Cal. Regular meetings on third Saturday of each month, at San Francisco.

RAILWAY CLUB OF PITTSBURGH. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburgh, Pa. Regular meetings on fourth Friday of each month at Hotel Henry.

RAILWAY SIGNALING CLUB. Sec.: C. O. Tilton, West Milwaukee, Wis. Annual meeting, Nov. 11, Pittsburg. Regular meetings on second Tuesday of January, March, May, Sept. and Nov.

RICHMOND RAILROAD CLUB. Sec.: F. O. Robinson, 8th & Main Sts., Richmond, Va. Regular meetings on second Thursday of each month.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: J. E. Buell, 906 20th Ave., Denver. Regular meetings on first Saturday after the 15th of each month.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS. Sec.: W. L. Capps, 12 W. 31st St., New York. Annual meeting, Nov. 20 and 21, 12 W. 31st St., N. Y.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

WESTERN RAILWAY CLUB. Sec.: Jos. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month. Nov. 5, paper on "The Administration of Streams Used in Irrigation," by Elwood Mead; Nov. 19, paper on "Fire Extinguishment in Chicago in 1902," by W. H. Musham and E. B. Ellicott; Dec. 3, paper on "Copper Mining in Upper Michigan," by J. F. Jackson; Dec. 17, paper on "Diversity of Engineering Methods on American Railways," by A. A. Schenck.

Personal.

—Mr. Paul Möller, of Berlin, a delegate of the Society of German Engineers and the representative of its official organ, the "Zeitschrift des Vereines deutscher Ingenieure," has come to America for a visit of several months. While here he will investigate our methods of works management and administration, our labor-saving machinery, and other matters of interest to German engineers.

—Mr. Ernst Wiener, the manager for Arthur Koppel, of 66-68 Broad street, New York, returned last week from an extensive business trip in Europe.

—Mr. Joseph A. McElroy, one of the "American invaders" of the British Isles, and a member of the electrical engineering and contracting firm of Macartney, McElroy & Co., is on a short visit home.

—Mr. John Hays Hammond has been recently in Colorado, inspecting mining properties.

—Mr. Ralph W. Pope, the secretary of the American Institute of Electrical Engineers, was married to Mrs. Katherine A. Durant, of Great Barrington, Mass., on October 1st, at Ocean Grove, N. J.

—Mr. Herbert Laws Webb, of the New York Telephone Co., has gone to England on a trip which will combine business and pleasure.

—Mr. J. W. Duntley, president of the Chicago Pneumatic Tool Co., has recently returned from a five weeks' trip to Europe, where his company is doing a large and growing business, and where it has made advantageous arrangements for the manufacture of its apparatus.

—Major S. Flood Page, of London, managing director of the Marconi Wireless Telegraph Co. and of the Marconi International Marine Communication Co., is visiting the United States.

—Mr. W. G. A. Millar, formerly manager of the Ornamental Department of the American Bridge Company, has been appointed purchasing agent of that company, with offices at 259 South Fourth street, Philadelphia.

—Warren Brothers Company, of Boston, announce with profound sorrow the death of their vice president, Mr. Ernest George Rutty, on Monday, October 6th.

Industrial Notes.

The Bradley Manufacturing Co., of Pittsburg, have secured, through the Osborne Engineering Co., of Cleveland, a large contract for the Midland Portland Cement Co., of Indianapolis, Ind., for the equipment of their plant. The contract for engines covers three 533-H. P. triple-expansion Willans central-valve engines, direct connected to three 400-K. W. Westinghouse A. C. generators; also, one 75 K. W. Westinghouse generator and Willans engine for a lighting set; also, one 25-K. W. Westinghouse exciter and Willans central valve engine for the same. C. H. Bradley, Jr., & Co., of Cleveland, will furnish four 250-H. P. Geary water-tube boilers, in addition to the boiler feed pumps, general service pump, fire pump, three Deane condensers, one 1,200-H. P. Cookson feed-water heater, and the necessary switch board.

—La Compagnie Fives-Lille has opened offices in the Maritime Building, New York, where it will be represented by Mr. E. P. Poisson, as engineer, and Mr. J. W. de Castro, as commercial agent. This well-known French company is prepared to bid on the complete erection and installation of both cane and beet sugar refineries, breweries and all classes of structural work.

—The William S. Haines Co., of Philadelphia, has made improvements in the Hanover oil filter, which increase its capacity threefold. The business which this company does with the Heintz steam trap is increasing very fast, the sales last year amounting to over ten thousand traps every month.

—The American School of Correspondence, formerly of Boston, has removed to Chicago, where it has made arrangements with the Armour Institute of Technology, whereby the management and members of the faculty of the Armour Institute cooperate with the American School by giving instruction in correspondence. The American School will be located on the Armour premises in Chicago, and a considerable number of the faculty of the Armour Institute are actively associated in the instruction of its students. Dr. Gunsaulus, President of the Armour Institute, is chairman of the advisory board of the American School, and in this capacity signs all American School diplomas. He is enthusiastic over the educational possibilities of this work, and it is at his invitation that the move has been made. He has entered into this work with the greatest enthusiasm, believing that it offers a means of bringing good college influence to the masses, such as no other form of education has ever offered. In fact, it is university extension work in every sense of the word. The American School in no way loses its identity by this change in location. It remains a separate institution under its own management, but with the fullest co-operation and help of the president of the Armour Institute of Technology.

—The U. Baird Machinery Company has been incorporated under the laws of the State of Pennsylvania, the style of the new company being Baird Machinery Company. The company is composed of C. A. Wolfe, H. A. Reed, W. B. Wolfe, O. P. Meckel and J. L. McCartney. As it has been in the past, it will continue to be the aim of this company to represent only the foremost and highest class manufacturers of machinery and supplies. Its large and constantly increasing business is sufficient proof that its methods are appreciated and approved by its customers.

—The W. W. Whitehead Co., of Davenport, Iowa, having changed their name to the Davenport Machine Works and disposed of their second-hand machinery business, announce that they are prepared to execute orders for light locomotives and heavy machinery of all sorts.

—Arthur Koppel, 66-68 Broad street, New York, has received an order from the Southern Pacific Railway for 15,000 tons of heavy steel rails, 80 lbs., A. S. C. E. section. These rails are for prompt shipment and to be delivered within the next two months. This firm is receiving many large contracts for railroad equipments. It manufactures a full line of industrial railroad goods, including cars of every description, locomotives, rails, wheels, axles, turn tables, switches, etc., and keeps a large stock always on hand ready for immediate shipment.

—The Bethlehem Steel Co. has unusual facilities for manufacturing heavy machinery for special purposes, such as: Hydraulic Machinery: Presses for forging, drawing, compressing, bending, upsetting, forming, shearing, punching. Intensifiers, accumula-

tors, pumps and pumping engines for high pressure. Machine Tools: Boring mills, planers and special heavy machine tools of all kinds. Machinery for Hoisting, Moving and Lifting: Cranes, drums for inclined planes, elevators, railroad cars for heavy transportation. Gearing: With cut out cast teeth, in single pieces up to the limit of transportation, and built up designs to any size desired. This company has also equipped its mills so that its capacity to roll angles, both as to length of bar and number of sizes, is considerably increased.

—John S. Cummings & Co., of Tunnelton, W. Va., have received a leter from James W. Paul, chief mine inspector of the State of West Virginia, in which he says: The "Standard" acetylene mine lamp you recently sent me has been given a thorough test and I find that it gives a clear, bright light and no smoke or offensive gases of combustion. With carbide at 12½ cents per pound, this lamp can be maintained for 50 hours at a cost of 25 cents, or ½ cent per hour. The principle on which the lamp is constructed is simple and easily understood. Its general adoption in all mines in which explosive gases are not found would very greatly benefit the health and safety of the underground employees.

—The Pelton Water Wheel Company reports having just closed a contract with the Vancouver Power Company, of Vancouver, B. C., covering three Pelton wheel units, with a combined capacity of 10,000 horse power. The wheels are for direct connection to electric generators; the power to be used for electric railway and manufacturing purposes in the vicinity of Vancouver. As instancing the progress of electric transmission, may be mentioned the fact that the Pelton Company has under construction at the present time Pelton water wheels aggregating 30,000 H. P., all of which are to be used in connection with electric transmission of power.

—The Empire Iron & Steel Co., of Niles, Ohio, began operations on Oct. 1st. They have 6 hot mills, 2 cold mills and a 3-high 24-inch bar mill. Their product will be sheet iron and sheet steel, and angles for light structural work. They will manufacture iron and steel sheets up to 60 inches wide and from No. 16 to No. 30 gauge. They will make a specialty of a "guaranteed" double refined iron sheet, and also of range steel and Bowsocket polished sheets. Their output of iron and steel angles will be about 100 tons per day. For the present the heaviest angles they will roll will be 4 by 4 inches. Their galvanizing plant will be in operation about Jan. 1st. The officers of the company are: Wade A. Taylor, president and treasurer; Chas. S. Thomas, vice-president and manager; J. F. O'Dea, secretary.

—The Chicago Pneumatic Tool Company report that owing to the great amount of business they are receiving from the South-West territory, they have deemed it advisable to again place a representative in that district, and therefore have located their Mr. W. C. Walker in St. Louis, with headquarters at 325 Lincoln Trust Building, 'Phone No. 2391. They believe this arrange ment will greatly facilitate handling the volume of business received from that territory and will be very advantageous to both themselves and their numerous customers.

—The National Machinery Co., of Tiffin, Ohio, have just shipped two more cars of wire-nail machines to the Pittsburgh Steel Co., Monesson, Pa., and three cars to the Colorado Fuel and Iron Co., Bessemer, Colo. Orders for bolt and nut machinery are coming in from all quarters, and the export business, especially with Asia, France and Australia, is exceptionally heavy.

—For the mammoth new bread and cracker bakery which the Ward-Mackey Co. are now erecting at 31st and Liberty streets, Pittsburgh, the Pittsburgh Gage & Supply Co. will furnish two 250-H. P. water-tube boilers. This company is also installing a complete White Star filtering system in the power house of the New York & Stamford Street Railway Co., Port Chester, N. Y.

—The Foster Engineering Company, of Newark, N. J., have received many orders recently for their well known Class W, back-pressure, automatic safety stop, combination, non-return and other valves.

—The Alberger Condenser Company, of 95 Liberty street, New York, report the following among important orders recently received for high vacuum condensing apparatus: Belt Light & Power Co.; Pennsylvania Sugar Refinery; Sharon Steel Co.; Port Huron Light & Power Co.; Hartford Street Railway Co.; Binghamton Light,

Heat & Power Co. The equipment for the above plants consists of Alberger barometric or surface condensers, with improved vacuum and circulating pumps and the necessary appurtenances for producing the high vacuum required by the use of steam turbines which are being installed in most of the above plants.

—The Philadelphia Pneumatic Tool Co. reports that in the month of August they broke all previous records in the amount of goods shipped, although from present indications, September will establish a new record in that respect. Recent large orders have been received from the Cambria Steel Co., Pennsylvania Steel Co., New York Shipbuilding Co., Newport News Shipbuilding & Dry Dock Co., and the Grand Trunk Ry. Co. Foreign orders have been received from Paris, London and Copenhagen. More orders have come in for rotary drills during the past two months than ever before. This company has just added to its machine shop equipment eight engine lathes, two automatic machines, two turret lathes, two grinding machines, one Fellows gear shaper, six drill presses, one universal milling machine, one twist drill grinder and a number of other minor machine tools.

—A new battleship of 16,500 tons and 18,000 horse power has just been contracted for by the British Admiralty. Niclausse boilers have been specified, this being the eighth ship of the British Navy in which these boilers have been ordered in the past sixteen months. The total Niclausse horse power in the British Navy, in operation or contracted for, is now 114,000, against 105,000 in the United States Navy.

—The Waterbury Farrel Foundry & Machine Co., of Waterbury, Conn., have erected new buildings, and have equipped all departments of their shops with electric drive, so that with their new tools they will have an up-to-date plant in all respects.

—The Guarantee Electric Co. report that business has been exceedingly good during the past year. They have had no dull season and believe 1902 will show as their most successful year. Their growth has surprised even themselves and some time ago they found that their business was increasing to such an extent that they would be unable to handle it in the way they would like to, in the building they were occupying. They therefore secured a lease in the new Borden Building, Clinton and Adams St., Chicago, half a block from where they have been located, into which they have just removed. There has been no change in the management during the year. Mr. Chas. E. Gregory is still president, Mr. G. B. Shaw, treasurer, and Mr. A. T. Walcott, superintendent.

—The Steam Boiler Equipment Co., of New York, had a notable exhibit at the recent convention of the National Association of Stationary Engineers, two of the boilers in use at the Massachusetts Institute of Technology, where the convention was held, being equipped with their "hydrocarbon" system. These boilers were in daily operation and the ability of the system to prevent the objectionable smoke from the use of soft or bituminous coal was fully demonstrated to the satisfaction of a large number of delegates.

—The Detroit Graphite Manufacturing Co. has recently received large orders for its superior graphite paint from Manila and from San Juan, Porto Rico.

—The National-Acme Manufacturing Company, of Cleveland, anounce the opening of their western office, Geo. D. Grant, Manager, at 2 and 4 South Canal street, Chicago.

—The new plant of the Millers Falls Paper Co., at Millers Falls, will be electrically driven throughout. The contract for the entire equipment covering generators, motors, arc and incandescent lights, etc., has been placed with Sargent, Conant & Co., of Boston.

—The Cleveland Machine Screw Co. has changed its title to the Cleveland Automatic Machine Co.

—The Crocker-Wheeler Company recently held at its works at Ampere, N. J., its annual Managers' Convention. The annual banquet was held at the Engineers' Club. Those present were the officers of the company: Schuyler S. Wheeler, Gano S. Dunn, W. L. Brownell, Putnam A. Bates, C. N. Wheeler, and F. V. Henshaw; and the branch managers: Samuel Russell, Jr., Julian Roe, J. Hally Craig, Louis P. Hall, W. H. Wissing, Francis B. DeGress, Henry J. Sage, William A. Doble and Harold Lomas,

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Agricultural Machinery.

Catalogue "P," with illustrations and descriptions, in Spanish and English, of plows, cultivators, harrows, corn planters and many other kinds of agricultural machinery. 10¾ by 7 in.; pp. 64. Also, catalogue with illustrated descriptions, in Spanish and English, of engines, boilers, threshers, horse powers, saw mills and other machinery for farm and country work. 7 by 10 in.; pp. 95. A. B. Farquhar & Co., New York.

Air Compressors.

Catalogue "C," second edition, with illustrated descriptions of air and gas compressors and auxiliary apparatus. Also, useful tables and data. 9 by 6 in.; pp. 135. Rand Drill Co., New York.

Catalogue, with illustrations and descriptions of air compressing machinery in various styles and for many uses. 7¼ by 5¾ in.; pp. 102. Also, catalogue and pamphlets devoted to pumping machinery. The Geo. F. Blake Manufacturing Co., New York.

Cars.

Large, cloth-bound book, with half-tone illustrations, diagrams and descriptions of Goodwin patent cars for dumping and discharging all kinds of material with the least expenditure of time and labor. 12½ by 17 in.; pp. 60. Goodwin Car Co., New York.

Conveying Machinery.

Catalogue D, bound in flexible cloth covers, with illustrations, descriptions, and price lists of elevating and conveying machinery, coal handling equipment, stone crushing machinery, and power transmitting machinery. 9 by 6 in.; pp. 127. The Aultman Co., Canton, O.

Catalogue No. 26, a cloth-bound book with illustrations, descriptions and price lists of Caldwell Helicoid and other kinds of conveying, elevating and power-transmitting machinery and accessories. 7¾ by 5½ in.; pp. 441. H. W. Caldwell & Son Co., Chicago.

Cranes.

Booklet with illustrated descriptions, in German, of traveling cranes operated electrically and by hand, particularly those shown at the Düsseldorf Exposition. Ludwig Stuckenholz, Wetter on the Ruhr, Germany.

Digging Machinery.

Catalogue "1901," with illustrated descriptions and price lists of the Hayward "orange-peel" and "clam-shell" buckets for excavating and dredging, and illustrations of these buckets as used with other machinery in a great variety of dredging and excavating work. 6 by 9½ in.; pp. 81. The Hayward Co., 97 Cedar St., New York.

Electric Apparatus.

A collection of bulletins, in cloth binder, with illustrated descriptions of many kinds of electric machinery and apparatus and their various applications. 11 by 8½ in. Also special catalogues and pamphlets, with many illustrations, devoted to electric pumping machinery, arc lamps, incandescent lamps, electric driving, small motors, and other electric apparatus, and their applications. General Electric Co., Schenectady, N. Y.

Electric Cranes.

Large, cloth-bound book, with half-tone illustrations and descriptions of electric traveling cranes and of the plants where they are installed. Also telegraph code. 9 by 12 in.; pp. 93. Shaw Electric Crane Co., Muskegon, Mich.

Gearing.

Catalogue with illustrations, descriptions and list of gearing, sheaves, pulleys, etc. 7½ by 5 in.; pp. 235. Also catalogue of the Poole-Leffel turbine water-wheel and price list of shafting, pulleys and hangers. Robert Poole & Son Co., Baltimore.

Furnaces.

Large, cloth-bound book containing specifications and designs for internal furnace tubular boilers with Morison suspension corrugated furnaces, and illustra-

tions and descriptions of the Morison furnaces, furnace fronts and doors. 11 by 9 in.; pp. 38. The Continental Iron Works, New York.

Gas Burners.

Pamphlet, with illustrated descriptions of the Stamford mantle gas burner and of the Stamford mantles for incandescent gas lighting, and high-pressure mantles for gas, gasoline and oil mantle lamps. Stamford Gas Stove Co., Stamford, Conn.

Gas Machines.

Pamphlet with illustrated descriptions of Tirrill's Equalizing gas machine, burners and other auxiliary apparatus for lighting, cooking, heating and power in isolated plants. Also, illustrations of many buildings where this system is used, with testimonials. 6 by 9¼ in.; pp. 80. Tirrill Gas Machine Lighting Co., New York.

Grinding Machines.

Book devoted to the construction and use of universal and plain grinding machines for cylindrical, conical and plane face surface work, with illustrations and descriptions of machines. 9 by 6 in.; pp. 103. Landis Tool Co., Waynesboro, Pa.

Light Locomotives.

Catalogue (ninth edition), bound in flexible cloth covers, with illustrations and descriptions of light locomotives for steam and compressed air, in every variety of size, gauge and design. Also useful tables and data. 9 by 6 in.; pp. 236. H. K. Porter Co., Pittsburg.

Locomotives.

Cloth-bound catalogue, with illustrations and descriptions of simple and compound locomotives of many types, history of the Brooks Locomotive Works, tables of useful data and telegraph code. 9½ by 6 in.; pp. 336. Brooks Locomotive Works, Dunkirk, N. Y.

Machine Tools.

Large, cloth-bound catalogue with illustrations and descriptions of all kinds of improved machine tools for working metal. 9½ by 7½ in.; pp. 354. William Sellers & Co., Inc., Philadelphia.

Catalogue, with illustrations and descriptions of shapers, gear cutters, drills and other high-class machine tools. 9 by 6 in.; pp. 177. Gould & Eberhardt, Newark, N. J.

Oil Filter.

Booklet, devoted to the "White Star" oil filter, for purifying dirty lubricating oil. Pittsburgh Gage & Supply Co., Pittsburg, Pa.

Pneumatic Cranes.

Large pamphlet, with half-tone illustrations and descriptions of revolving pneumatic cranes, particularly adapted for loading and unloading cars, pneumatic jack and pneumatic painting machine. 12¼ by 9¼ in.; pp. 16. The Garry Iron & Steel Roofing Co., Cleveland.

Portland Cement.

Pamphlet devoted to Lägerdorfer portland cement, manufactured by Eugene Lion & Co., Lägerdorf, Holstein, Germany. There is an account of the works and process of manufacture, tables of tests, and illustrated descriptions of its application in many places in the United States. 6 by 9 in.; pp. 84. Also illustrated pamphlet devoted to "Lehigh" portland cement and many of its applications. 6 by 8 in.; pp. 47. Kelley Island Lime & Transport Co., Cleveland.

Prospecting Machines.

Catalogue No. 2, with illustrations and full descriptions of Keystone mineral prospecting machines for exploring and assaying placer gold mines, exploring for coal, lead, zinc, iron, etc., and making soundings for bridge piers and foundations. Keystone Driller Co., Beaver Falls, Pa.

Pumping Machinery.

General catalogue No. 29, with illustrated descriptions of steam and electric pumps for all kinds of service, condensers and water meters. 8½ by 6½ in.; pp. 98. Henry R. Worthington, New York.

Catalogue, with illustrations and descriptions of electric power pumps and accessories for all purposes. 7½ by 5¾ in.; pp. 143. Knowles Steam Pump Works, New York.

Riveting Machines.

Catalogue No. 5, with illustrations and descriptions of "Pittsburg" riveting machines for all kinds of riveting work, and which can be operated by air, steam or hydraulic pressure. Also useful information and tables on rivets and riveting. 6 by 9 in.; pp. 48. Chester B. Albree, Iron Works, Allegheny, Pa.

Rock Drills.

Catalogue "D," with illustrated descriptions of rock drills and drill mountings for mines, quarries and tunnels, and accounts of various applications. 9 by 6 in.; pp. 81. Rand Drill Co., New York.

Roofing.

Catalogue and price list of iron and steel roofing, siding and ceiling, cornices, piping, etc., and iron and steel buildings and roof trusses. 10½ by 8 in.; pp. 127. The Garry Iron & Steel Roofing Co., Cleveland.

Steam Apparatus.

Illustrated trade catalogues and price list (G-11-B) of Bundy radiators, boilers, and tank heaters, pipe and fittings, boiler tubes, brass and iron goods for steam, water, gas, air and electricity, and other specialties and supplies. 6¾ by 4¾ in.; pp. 334. Also catalogues S-12, S-14 and S-15, devoted respectively to Bundy separators, Bundy feed-water heaters and Bundy steam traps. A. A. Griffing Iron Co., Jersey City, N. J.

Steam Engines.

Large catalogue, with half-tone illustrations and descriptions of heavy-duty Hamilton-Corliss steam engines and plants where they are installed. 10 by 14 in.; pp. 52. Also illustrated catalogue of standard girder frame and "series B" Hamilton-Corliss engines. The Hooven, Owens, Rentschler Co., Hamilton, O.

Cloth-bound book, with illustrations and descriptions of the Porter-Allen steam engine, and directions for setting and running it. 9¼ by 6 in.; pp. 59. Also pamphlets devoted respectively to centrifugal pumping machinery and the Weiss counter-current condenser. Southwark Foundry and Machine Co., Philadelphia.

Steam Goods.

Catalogue in flexible cloth covers, with illustrations, descriptions and price list of brass and iron valves, injectors, whistles, lubricators, oil and grease cups, and steam specialties. 7 by 5 in.; pp. 208. The Lunkenheimer Co., Cincinnati.

Cloth-bound book, with illustrations, descriptions and price lists of pressure and vacuum gauges for all purposes, safety valves, water and cylinder relief valves, and steam engine and boiler appliances in general. Also lists of users, testimonials, and useful tables and data. 9½ by 6½ in.; pp. 168. Also folder devoted to the Star improved steam engine indicator. Star Brass Manufacturing Co., Boston.

Steam Shovels.

Catalogue No. 1, cloth-bound, with half-tone illustrations and descriptions large steam shovels and wrecking cranes. 7 by 10 in.; pp. 64. The Bucyrus Co., South Milwaukee, Wis.

A series of pamphlets devoted to steam shovels, with illustrations and descriptions of boom shovels and other styles and their application in different kinds of work. The Vulcan Iron Works Co., Toledo, O.

Thermometers.

Catalogue in separate parts with illustrated descriptions of thermometers for various purposes. Part 1 is devoted to those for steam and power plants, part 3, cold storage and refrigeration, part 4, brewing and distilling; part 5, canning, packing and preserving. 9¼ by 6 in. The Hohmann & Maurer Mfg. Co., Rochester, N. Y.

Turret Machinery.

Illustrated catalogue of turret lathes and turret machinery of every other description and complete outfit of tools therefor. 6 by 4 in.; pp. 253. Bardons & Oliver, Cleveland.

Wage Calculator.

Booklet, with illustration, description and price list of the New Idea Calculator for mechanically computing wages. 5¾ by 3¼ in.; pp. 12. Carlton Manufacturing Co., New York.

Windmills.

General catalogue No. 42, with flexible cloth covers, illustrating and describing Star windmills, Hoosier and Fast Mail pumps, and many accessory tools, fittings and apparatus. 9 by 5½ in.; pp. 248. Flint & Walling Mfg. Co., Kendallville, Ind.

Wire Machinery.

Illustrated catalogue of wire and metal working machinery. 12 by 9 in.; pp. 37. Also folder with illustrated description of multiple-spindle drill with automatic feeds. The F. B. Shuster Co., New Haven, Conn.

Wire Rope.

A booklet containing the "Song of the Elevator," verses recounting the merits of Leschen's patent flattened strand wire rope. A. Leschen & Sons Rope Co., St. Louis.

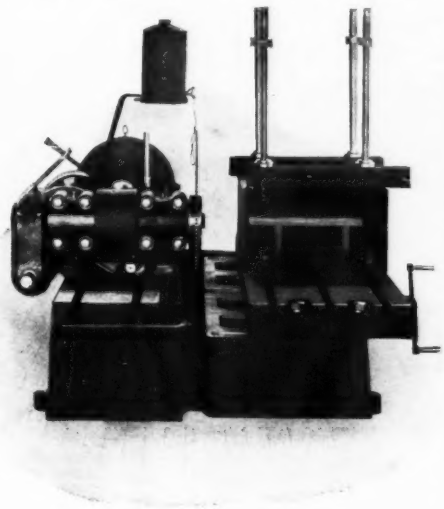
IMPROVED MACHINERY

New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Metal-Cutting Machines.

THE Q & C Company have recently placed on the market a line of metal cutting machines that embody many novel features and improvements over those made by them in the past, with which the users of this class of machinery have become so familiar. The new machines are of two distinct types: "Bryant" saws, in which the saw blade is driven by a gear or sprocket wheel engaging with the teeth formed on the periphery of the blade, and arbor-driven saws, in which the saw blade is driven by a central mandrel or arbor. Both types of these saws are made in two styles: Cut-off saws and universal saws. In the cut-off type, the blade travel is short and the machine is especially designed for cutting off bars, round and square, structural shapes, etc. In the universal type, the travel of the blade is longer and the machine is fitted with an upper side table on which the work can be cut off for the entire length of the travel of the saw blade, while they are also arranged with V blocks and lower tables for cutting bars and shapes.



Q & C METAL-CUTTING MACHINE.

The illustrations herewith show two views of a "Bryant" cut-off type of machine, one belt driven, and the other motor driven. Any machine can, when desired, be mounted on a circular base which can be completely rotated by rack and pinion, this being a very desirable feature where there is not sufficient room for swinging a long beam. Lateral adjustment of side tables can be furnished, if required, so that work can be adjusted for cutting after being secured.

Special attention has been given to the arrangement of the tables on all machines so that work can be placed most advantageously for cutting with a minimum distance of blade travel. The longer side tables are of sufficient length to enable beams, etc., to be properly supported when being cut off at any angle up to 45 degrees, and to permit of steel castings within the capacity of the machines being secured to it.

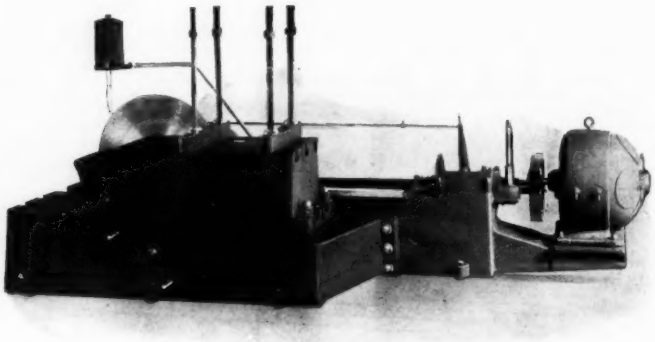
All machines are fitted with the Q & C Company's latest type of friction feed, giving an automatic feed variable with the machine in motion from ¼ inch to one inch per minute on the "Bryant" saw and from 3/16 to 13/16 inch per minute on the arbor driven saw. The feed is powerful in its action and gives a constant driving force

throughout its entire range. The feed wheel is connected to the feed screw by a clutch operated by a lever, by moving which it is engaged or disengaged. In the universal saws the clutch also operates the power return movement with which these machines are fitted. A rod attached to this lever engaging with the carriage, operates an automatic stop in both directions. When the clutch is disengaged the carriage can be moved in either direction by hand. The feed nut is solid, 6 inches in length and bushed with bronze. It is bolted and tongued to the carriage, and can be readily moved without dismantling the machine.

entirely enclosed, avoiding dust and the wear it entails when machines are not advantageously placed. The shears and tables are of strong and rigid design and are provided with oil troughs so that all lubricant is returned to the central trough underneath the saw blade.

The Q & C Co. being the only manufacturers of both these types of machines, are consequently in position to furnish to their customers that type of machine which experience has shown to be best adapted to accomplish the required work with the greatest possible economy.

Further information and catalogue can be obtained from The Q & C Co., Western Union Bldg., Chicago, or 114 Liberty Street, New York.



Q & C METAL-CUTTING MACHINE.

The "Bryant" saw carriage is in two parts, the sprocket shaft bearing being cast in one piece with the worm-gear hood and movable 2½ inches towards the axis of the blade, allowing for a wear of 5 inches in its diameter. The sprocket is removable, and all sprockets on these saws are interchangeable, and readily replaced.

The arbor driven saw carriage is of good design and exceedingly strong and rigid. All bearings are divided at right angles to the direction of the wear and are of extra large proportions. Both arbor gear and pinion are solid with the shaft, the pinion being hardened. The width of the face is large, and the liberal proportions employed have produced a very rigid and quiet-running machine.

All gears in both types of machines are

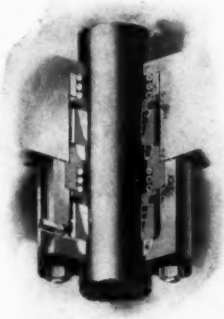
Metallic Packing.

THE United States Metallic Packing Company has long made a specialty of packing valve stems and piston rods on marine and stationary steam engines, and at the present time the type shown in the accompanying illustration, and known as Class 1 Packing, represents the highest stage of development in that line.

This is a double packing, the inner packing composed of one set of babbitt metal rings, which, with their parts, do most of the work. They are separated from the rest of the packing by a dividing piece; then outside of this comes the second set of pack-

ing. Should any water or steam happen to leak through the first set of rings it is caught by the second set and can be drained off; and should the first set of rings wear out or fail while under heavy service, the second set is already on the rod ready to take up the work of the first set at all times.

The great success of this packing is due to its flexibility. No matter how badly an



U. S. METALLIC PACKING.

engine is out of line or how much play there is between cross-heads and guides or between piston and cylinder, the packing floats with the rod, offering very little resistance, so that a hot rod occurring from any fault of the packing itself is practically unknown. This flexibility is due to the combination of the ball joint with the sliding face of the vibrating cup; other types of packing not having this flexibility cause severe wear on rods and packing, accompanied by a great deal of friction.

In order to make a packing thoroughly successful it must be automatically adjusted as wear takes place. With these packings this is done by the steam pressure itself. The springs merely hold the parts of the packings in place when steam is released, and exert only about 10 per cent. of the total pressure on the packing.

All packings are designed to suit the work to which they are to be applied. A packing designed for 250 pounds pressure would not give good results at 50 pounds pressure; so, in order to make a successful packing the conditions under which the packing is to operate must be known.

Any further information on this subject will be gladly furnished by the United States Metallic Packing Company, of 427 North 13th street, Philadelphia.

Fire Hose.

A LARGE proportion of the mills throughout the country are insured in companies which come under the jurisdiction of either the Associated Factory Mutual Insurance Companies or the National Fire Protection Association, and are obliged to have fire hose which fully meets the requirements of these two organizations.

Such a hose is the "American Underwriters" fire hose, which is manufactured by the Boston Belting Company, of Boston, and which is accepted and recommended by the above-named associations. The rubber-lined cotton hose of this kind, which is shown in the accompanying illustration, is adapted for outside use on portable hose reels and on the yard hydrants of factories, and is made in fifty-foot lengths. The unlined linen hose, made from the very best quality of imported Scotch flax, is a reliable safeguard for inside use where it is necessary to hang fire hose up in warm rooms, corridors, stairway towers of textile mills, etc. It is light, compact and convenient, and is furnished in any length desired.

The Boston Belting Company supplies also couplings, playpipes and other accessories to the hose, and has designed a hydrant and hose house, intended for erection

in mill yards, which preserves the hose in good condition and is arranged so as to give easy access to the hydrant.

Any further particulars regarding these matters will be gladly furnished by the Boston Belting Company.

"Ceco" Electrical Machinery.

THE Christensen Engineering Company, Milwaukee, has just placed upon the market complete new lines of "Ceco" electrical machinery, including direct-current motors and generators, alternators and transformers.

For several years this company has been manufacturing electric motors for driving air compressors used in connection with the well known Christensen air brake equipments on electric cars. More than 6500 of these motors are in highly satisfactory service throughout the world. The company has also built a large number of motors of various capacieies for driving air compressors used in general commercial service, and all the motors for driving machine tools and shafting in their own works.

In order to manufacture these motors the company has maintained an extensive equipment, particularly suited to the purpose. Some time ago it was decided to greatly increase the company's manufacturing facilities and to develop a complete line of electrical machinery of the highest grade.

The policy of the Christensen Engineering Co. has always been not to place any apparatus upon the market until the entire work of development has been satisfactorily completed. The exceedingly high reputation and remarkable success of the air brake apparatus are largely due to this policy. Therefore the company has made no announcement regarding its electrical apparatus until the various lines were completely developed and severely tested. The results proved that these machines are in design, construction and performance worthy of the high reputation now accorded to the Christensen air brake equipments.

"CECO" ENCLOSED ELECTRIC MOTOR.

The company is now prepared to build machines up to 1,500 K. W. in capacity, suitable for general power, railway or lighting service.

The line of "Ceco" motors known as

Type C. E., ranging in capacity from 2 to 50 H. P., is illustrated herewith. These motors are made in three styles, open, semi-enclosed and enclosed. The standard styles are belted, but any motor can be geared or direct connected to the driven machine or shaft. The C. E. motors are for general service in industrial establishments of every kind where a high-grade, durable and reliable machine is required.

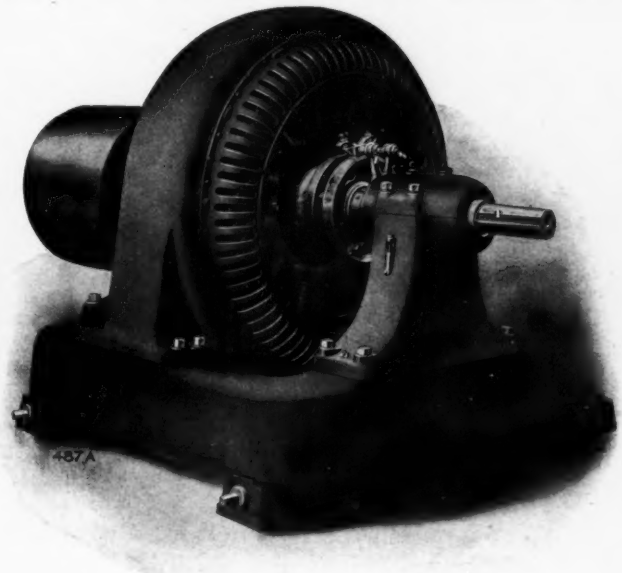
The motors are mounted on a cast iron sub-base which is composed of a single casting, thus insuring perfect alignment. Belt tension is accomplished by moving the motor upon the sub-base in the usual manner.

The ventilation of the armature and commutator is remarkably good, thus insuring a low temperature while running continuously. The "Ceco" motors will operate at their rated loads without the temperature of the armatures rising more than 30° C. The rise in temperature of the field coils under these conditions will not exceed 40°C, and of the commutator 45°C. These machines will operate from no load to full load with the brushes in a fixed position without sparking. They will also operate for two hours with 25 per cent overload, and for two or three minutes with 50 per cent. overload without injurious heating or sparking.

These motors will operate in any position in which the shaft is horizontal. This is accomplished by shifting the bearing brackets on the frame so that the oil chambers remain in the proper position, whether the motor is secured to the floor, the ceiling or the side wall.

A rigid system has been established for the inspection of the parts of each machine while under construction, and there is no poor material or workmanship to hide under canvas, rope, or other "protecting" material. When completed each machine is given a severe running and high insulation test. Then the frame is rubbed with a good filler and painted. All bright parts are polished, so that in addition to being compact in design, substantial in construction and superior in performance, each machine presents a graceful and pleasing appearance.

All the "Ceco" alternators, whether belted, engine type or direct couple, are of the revolving field type, thus leaving the armature stationary, and easily accessible. By



"CECO" POLYPHASE ALTERNATOR.

this form of construction the difficulties of properly insulating the armature coils which have caused much trouble in rotating armatures are eliminated.

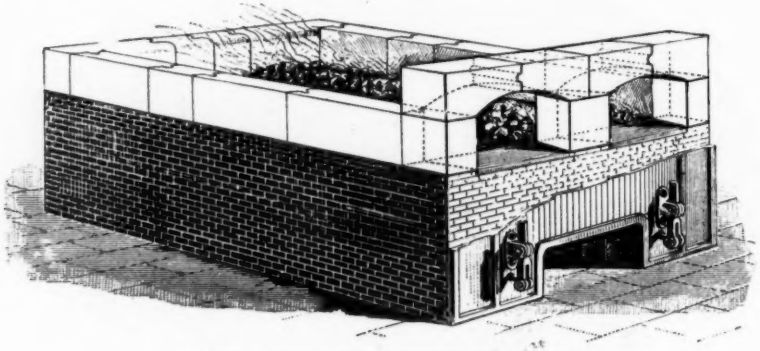
The frame consists of cast iron housings, into which rings of laminated steel with inwardly projecting teeth are assembled, thereby forming slots for receiving the armature windings. The armature is designed with six slots per pole so that it may be wound or rewound for single, 2- or 3-phase as required. The armature frames for the belt-driven alternators are cast in one piece, while the frames for the direct driven machines are divided horizontally. Instead of the usual practice of having several coils for the same machine, all the armature coils for each "Ceco" alternator are of the same size and shape, so that they are interchangeable. The coils are specially insulated, so that they will stand without injury the highest temperature that will ever be reached in service. Standard frequencies are 60 and 25 cycles per second. With the exception of the smaller sizes, "Ceco" alternators can be wound for any voltage up to 15,000.

The Christensen Engineering Company is entering the electrical manufacturing business with exceptional advantages. Its present works were completed but two years ago and no expense was spared in providing every facility for the rapid, accurate and economical manufacture of its product. The equipments of machine tools, cranes, special machines, etc., is unusually extensive, modern and complete. The foundation for a 250-foot extension to the main machine shop, which is 186 feet in width, has just been completed. There are three stories, and this extension will provide 88,000 additional square feet of floor space.

Any further information concerning "Ceco" electrical machinery will be gladly furnished on request by the Christensen Engineering Co.

Steel-Mixture Fire Brick.

IN the construction of fire-boxes and furnaces it is of the greatest importance to have strong and durable, as well as refractory material. These desirable qualities are possessed in a high degree by the "steel mixture" blocks and arches manufactured by the McLeod & Henry Company of Troy, N. Y.



M'LEOD & HENRY STEEL MIXTURE FIRE BLOCKS.

While iron boiler door arches melt at a temperature of 2,200 degrees, the "steel-mixture" arches will not fuse until a temperature of 4,000 degrees is reached.

The fire-box blocks are tongued and grooved, and come in sizes from 12 to 16 inches high and 6 inches thick. When in place, they make a wall the height of the fire all around the fire-box, and this wall is and remains smooth and solid, whereas, when ordinary small fire brick is used, the clay shrinks and leaves space for clinkers.

The "steel-mixture" fire brick has been extensively applied with great success. Any further information concerning it will be cheerfully given by the McLeod & Henry Company.